JUN 11 1956

NINETY-SEVENTH YEAR

AMERICAN Gas Journal

JUNE 1956

Only Magazine Published Exclusively for the Gas Utility Industry

B 597451

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Rockwell aluminum meters have crisp, clean lines. They reflect the mode and spirit of the best modern design. Installed in any home setting, they complement their surroundings . . . give your customers the rightful impression of the best service from your use of the finest, safest equipment.

Single Joint

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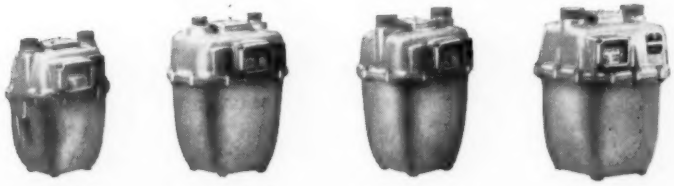
The only complete line of domestic size aluminum meters



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The only natural gas odorant in use that is completely stable in high pressure lines—1000 psi or more—and at low temperatures—0°F or lower. Calodorant "C" is equally effective at medium and low pressures in either transmission or distribution systems—large or small.

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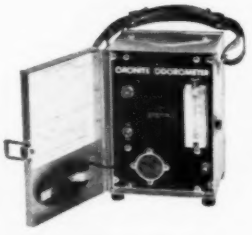

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Gasket is completely SEALED and protected; at the bell face by a Monel Metal Seal Band; at the spigot by hard, vulcanized gasket tip, acting as a plug. Equalized pressure forces gasket into every crevice in the joint, sealing the leak at its source. Sturdy malleable iron Compression and Anchor Rings—shaped and pressure-tested before shipping. Large 3/4" bolts. Plated or unplated. Malleable iron bolts furnished on special request.

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SKINNER-SEAL BELL JOINT CLAMP

The man in the picture isn't hanging out the family wash.

As a matter of fact, the family wash is hanging him.

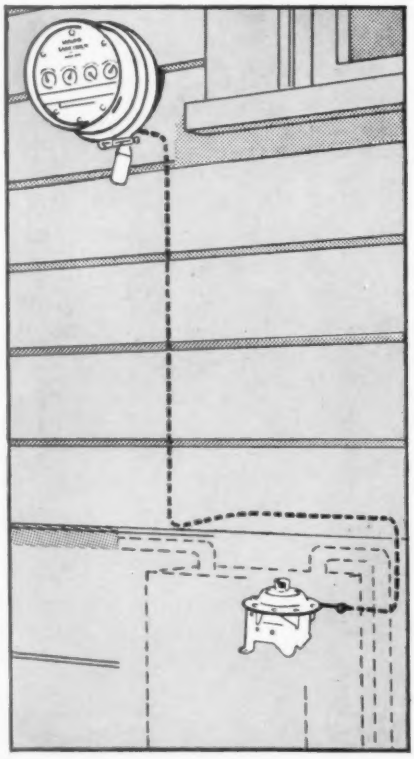
And it isn't even his family. The man in the picture is a gas meter reader. His job is to go down into a lot of strange basements and find out how much gas the customers have been using.

In doing this, he frequently runs into some uncomfortable situations. For instance, we know of a gas meter reader who went down into the basement of a house in 1942 and was never heard from again.

Naturally, it put his company in an embarrassing situation – they didn't know how much to charge for the amount of gas used.

Now this sort of thing *can* be avoided. You can install Sangamo Gas Telemeters on your present tin meters. The Telemeter brings the gas meter reading *outside* the premises. And the nice thing about a Telemeter is that no one who ever tried reading one has ever disappeared.

We wrote everything down we thought you'd like to know about Telemeters and had it published under the title, "Outdoor meter reading is here . . ." or Bulletin 802. We've reserved a copy for you, so write for it today.



it's easier to get the reading ON THE OUTSIDE!

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SPRINGFIELD, ILLINOIS

GT56-3

memo:

from the publisher

Through the course of years, a good many of our more avid readers perhaps have noticed two symbols that are displayed in the "masthead" of this publication. These designate our membership in two Associations — are, in fact, "symbols of integrity." Their meaning to you, the reader, is both real and important.

The "ABC" symbol, for example tells you that we are members of the Audit Bureau of Circulations. This means that our subscription lists are audited and verified semi-annually by unbiased and competent auditors. In addition to guaranteeing to our advertisers a verified, completely honest circulation — this symbol also proclaims that all of our subscribers are treated alike. And treated fairly. Circulation sales methods are rigidly controlled and must meet the highest standards of the profession.

The "ABP" symbol signifies membership in our industry's trade association — the Associated Business Publications; a membership, incidentally, that is partially predicated upon our adherence to the circulation methods and ethics evidenced by our ABC membership.

The Associated Business Publications, celebrating its Golden Anniversary in 1956, has worked for 50 years to bring about the evolution of businesspapers from their humble beginnings to the powerful force they are today.

As one of the 162 publications belonging to the ABP, we pledge ourselves to adhere to a Code of Ethics and Standards of Practice which means, among many other important things, that we are working constantly to improve our services to our readers.

This We Believe

(The ABP Code of Ethics)

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1. *To consider, first, the interests of the subscriber.*
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5. *To avoid unfair competition.*
6. *To determine what is the highest and largest function of the field which he serves, and then to strive in every legitimate way to promote that function.*

Joe B. Brooks

ABC / ABP

NINETY•SEVENTH YEAR

AMERICAN Gas Journal

JUNE, 1956

Only Magazine Published Exclusively for the Gas Utility Industry

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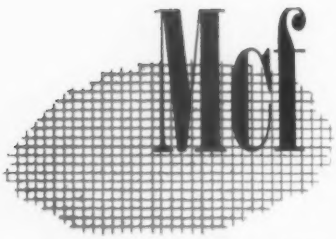

More than 600 offshore wells in the Gulf of Mexico are expected to be drilled this year, Felix Wormser, assistant secretary of the Department of the Interior, told an annual meeting of the North Texas Oil and Gas Association. There are now some 600 oil and gas producing offshore wells; about 360 were drilled in 1955 of which 45 were wild cats, he said.

An $18,000,000 natural gas absorption plant will be built near Fort St. John, British Columbia, by PACIFIC PETROLEUMS LIMITED. It will be one of the first industrial operations in northern British Columbia connected with the natural gas industry, and is being heralded as a forerunner of new chemical industries for British Columbia. The plant will process natural gas from the Peace River fields before it enters the WESTCOAST TRANSMISSION COMPANY LIMITED pipe line now under construction southward to the U. S.-Canadian border. Approximately 250 to 300 tons of sulfur will be produced daily by the plant, more than enough to meet requirements of the province's paper and pulp industry which is now dependent on imports. The plant will also produce large quantities of a high grade fuel in the form of gasoline, propanes, butanes and other products.

AMERICAN LOUISIANA PIPE LINE COMPANY, which won't have its new line in operation until this fall, has applied to the FPC to increase its line's capacity by 400,000,000 cu ft daily. The initial step in its expansion program would be the addition of 28,000 horsepower in compressor capacity and later, construction of two additional stations of 9000 horsepower each.

Canada plans to form a government corporation to be known as the NORTHERN ONTARIO PIPE LINE CROWN CORPORATION to help finance the TRANS-CANADA PIPE LINES, LTD. from Alberta to eastern Canada. The Crown corporation would build and lease a 675-mile section of line across Ontario which Trans-Canada says is economically infeasible at the present time.

MILWAUKEE GAS & LIGHT COMPANY has announced plans for spending $8,500,000 in its 1956 expansion program that will add 15,000 gas space heating customers to the firm's present 240,000 customers. Gas for the new service will be available this fall from AMERICAN LOUISIANA PIPE LINE COMPANY.

A battle is shaping up in the Carolinas between a number of applicants for the job of serving the Piedmont and East Coast of the Carolinas with natural gas service. The North Carolina State Utilities Commission has gone on record as favoring the NORTH CAROLINA NATURAL GAS CORPORATION's plan, in the role of intervenor before the FPC. North Carolina Natural Gas was given permission by the North Carolina State Utilities Commission last December to serve gas to two dozen eastern North Carolina communities. Meanwhile TRANS-CAROLINA PIPELINE CORPORATION has applied to the FPC for rights to serve substantially the same communities. Trans-Carolina would operate across both North and South Carolina.

WASHINGTON NATURAL GAS COMPANY has announced plans to spend $26,000,000 on new construction in the next five years. That figure compares with $22,000,000 spent in the past 75 years by the former SEATTLE GAS COMPANY and WASHINGTON GAS & ELECTRIC COMPANY which merged last November as Washington Natural. Approximately $1,400,000 was spent for construction last year, and $7,768,000 is planned for 1956 plant additions.

The gas industry's three segments — production, transmission and distribution — should get together now to reach an agreement on the solutions confronting them, especially, the producers, according to Jerome Kuykendall, chairman of the FPC. Speaking at the midyear meeting of the Independent Petroleum Association of America, he stated that he was "confident that agreements so arrived at, in consideration of the public interest as well as enlightened self interest, will be acceptable to and approved by the Congress and the President." He explained that the problem of determining what standards to use in making just and reasonable rates for independent natural gas producers is "to put it mildly, a difficult one."

PUBLIC SERVICE COMPANY of North Carolina is adding a variable cost-of-gas clause in its new rate schedules. The new clause, according to the North Carolina State Utilities Commission is "in no way to be interpreted as an automatic escalator clause provision." In substance, the clause says that the rates that Public Service customers pay are to be based on the cost-of-gas to the company. If costs increase or decrease, rates will be changed upon notice to and approval by the States Utilities Commission.

Do you want to know more about regulations under the Natural Gas Act? The FPC has issued a new pamphlet edition of regulations including approved forms. The edition contains subchapters E and G regulations under the Natural Gas Act in effect April 1, 1956. Copies of the pamphlet are available from the FPC, Washington 25, D. C. at 35 cents per copy. The order number is FPC- A-50.

A new court review of FPC rate-making formulas, the first since the HOPE NATURAL GAS COMPANY decision in 1944 may come from the U. S. Supreme Court some time in the near future. PANHANDLE EASTERN PIPE LINE COMPANY has recently filed an appeal to the decision of the U. S. Circuit Court of Appeals for the District of Columbia asking that an FPC rate-making order based on fair field price be set aside. There is little chance that the decision will be reached before the summer recess which usually starts in early June. Observers feel, however, that the court will agree to review this case, thereby setting up this important test case for argument and decision early in the fall term which begins in October.

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Extend lines... without shutdown!

H-17251 Extension Stopper Fitting.
Sizes 3", 4", 6" and 8".

You can extend dead-end lines without disrupting other services. Mueller Extension Stopper Fittings, from 1½" through 8", may be installed as dead-end caps when the pipe is laid. When additional services require the extension of the pipe, the fitting is stopped-off, the capped end of the pipe removed and the new pipe extension attached. Mueller Line Stopping Equipment is used to make the stop-off under pressure in a safe manner, without escape of gas.

Flanged cap extension stopper fittings in sizes 3", 4", 6" and 8" have 150 pound flanges and withstand pressures to 230 p.s.i. Threaded cap extension stopper fittings, sizes 1½" and 2", are available with cast iron caps to 250 p.s.i. or steel caps to 1200 p.s.i.

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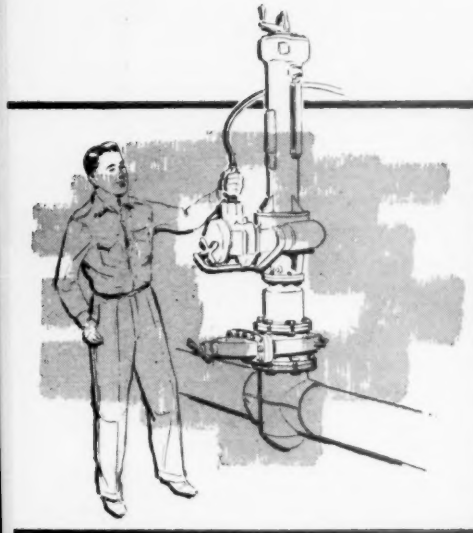
It is a simple matter to maintain flow while making a tie-in. Two Mueller Stopping Machines located above and below the point of tie-in completely isolate that section. Tie-in is made in complete safety, without loss of gas.

Flow is maintained by installing a completely separate by-pass line around the isolated section.

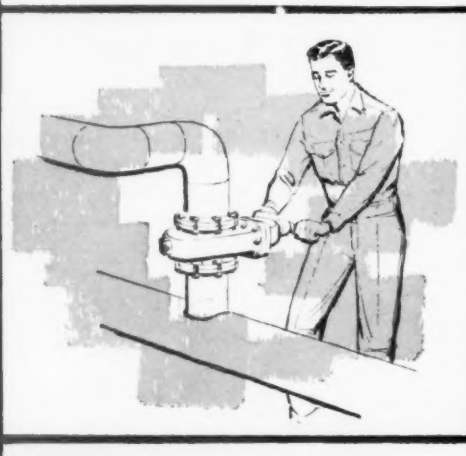
On 6″ and 8″ lines, for example, two Mueller H-17340 Stopping Machines isolate the section by making stop-offs through H-17255 line stopper fittings which are welded to the line. The H-17346 Completion Machine is used to plug the fittings after the stoppers are removed. Two H-17495 Save-a-Valve Drilling Nipples are installed above and below the isolated section to carry flow around stop-off.

Stopping Machines and fittings are available to fit pipe 1½″ through 12″. Smaller stop-offs may be made with Mueller Drilling Machines.

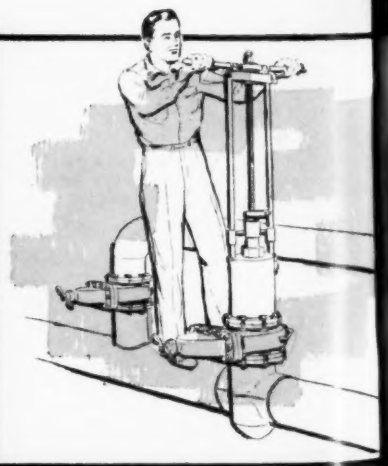
MUELLER NO-BLO® Method



STEP 2: Make cut through pipe. Install Mueller C1-36 or CC-36 Drilling Machine. Engage feed and drill completely through pipe. Retract boring bar, (shell cutter retains coupon), close valve, remove machine.

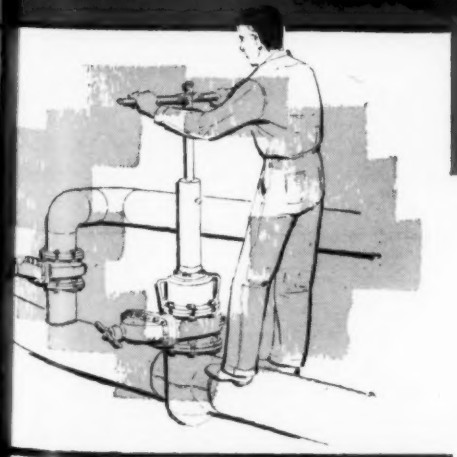


STEP 3: Attach by-pass line. Weld H-17495 Save-a-Valve Drilling Nipples to pipe above and below stopping machines. Install gate valves – drill through pipe, remove drilling machine and install by-pass line. Open valves.



STEP 4: Make stop-off. Attach wedge stopper to shaft of H-17340 Stopping Machine Bolt machine to gate valve. Open valve - lower and expand stopper. (Repeat procedure on other [illegible] and the section is completely isolated for [illegible]

STEP 1: Weld fitting to pipe. Install fitting around pipe. Tack weld halves of fitting together – position and weld to pipe with completion plug in fitting – hand tight. Test the welds for leakage. Attach gate valve to fitting.



STEP 5: Complete tie-in. After line has been ...ed in and tested, release stoppers and remove stopping ...machines. Install completion plugs with H-17346 Comple... ...on Machine. Tighten plug manually and bolt completion ...cap in place. Remove by-pass line and cap drilling nipples.

Write for the No-Blo® Method booklet, "Safe Operating Practice." It shows how other gas installations are made in a safe manner, without escape of gas.

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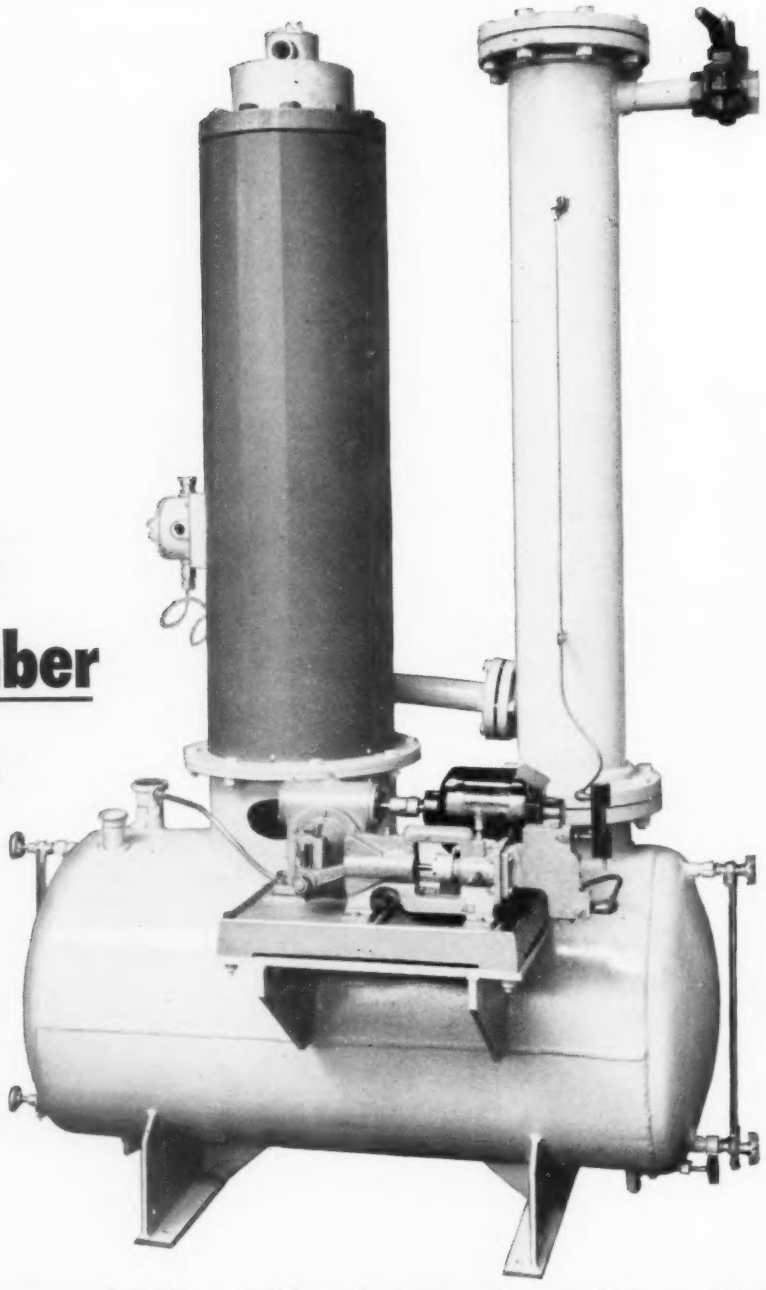

With Koppers equipment, the outlet stream—where the vaporized oil passes into the main flow—may be split into as many streams as required. Koppers-Baltimore Oil Foggers send a fine oil mist of great stability and carrying power through any dry gas system . . . stopping minute leaks, eliminating dust problems, safeguarding mains, joints, meters and regulators. And maintenance is easy, because only sweep gas is heated directly*—not oil—which means no objectionable sludge. Heating gas only makes it possible to use electrically energized, gas fired or steam heated sweep gas heaters. K-B Oil Foggers are available in all three types. All electrical equipment is housed in explosion-proof enclosures.

On all K-B units, of course, every component part is of the most reliable, trouble-free type possible to obtain. Regardless of which type will solve your problem, any Koppers-Baltimore Oil Fogger will protect your valuable gas distribution system at relatively small cost. Koppers engineers have been recognized authorities in the gas industry for more than 80 years. Koppers has already installed more than 600 successful Oil Foggers . . . saving thousands of dollars in gas distribution maintenance. For more complete information, technical data, specifications or a quotation without obligation, write to: KOPPERS COMPANY, INC., *Gas Apparatus Dept.*, 4206 Scott St., Baltimore 3, Md.

*Process patented.

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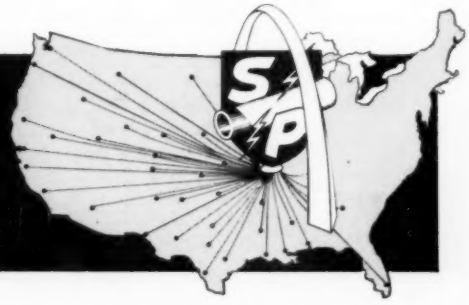

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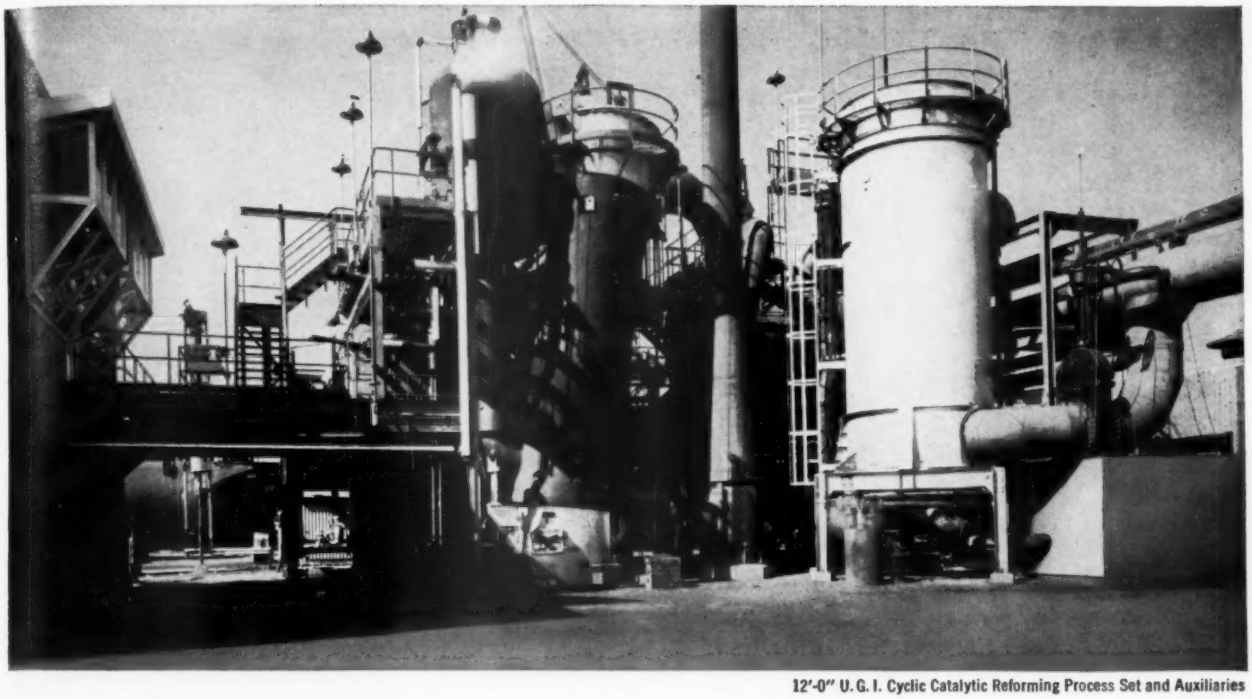

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. . . with the flexibility to produce, at low operating and investment costs, gases ranging from 325 to 1,000 Btu and to meet many of the interchangeability requirements of the gas industry

*Patents Pending

CCR

LIST OF INSTALLATIONS

COMPANY	LOCATION	NUMBER OF SETS	
Allentown-Bethlehem Gas Company	Bethlehem, Pa.	First	1
Citizens Gas and Coke Utility	Indianapolis, Ind.	First	1
Consumers Gas Company	Reading, Pa.	First	1
The Harrisburg Gas Company	Steelton, Pa.	First	1
Philadelphia Electric Company	West Conshohocken, Pa.	First	1
The Philadelphia Gas Works Company	Philadelphia, Pa.	First	1
	Philadelphia, Pa.	Second	1
	Philadelphia, Pa.	Third	1
	Philadelphia, Pa.	Fourth	1
Public Service Electric and Gas Company	Paterson, N.J.	First	1
	Harrison, N.J.	Second	2
	Jersey City, N.J.	Third	1
	Harrison, N.J.	Fourth	1
Rochester Gas and Electric Corp.	Rochester, N.Y.	First	1
	Rochester, N.Y.	Second	1
	TOTAL		16

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with Many Advanced Features to Increase Versatility and Earning Power

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Additional features of the new Sherman Major Power Digger include twin crowd cylinders, heavy steel plate construction, large diameter hinge pins, heavy steel castings, replaceable hardened steel bearings at hinge points, and a newly designed dipstick, boom, cylinders, bucket and sub-frame assembly.

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See the Sherman Major Power Digger soon at your local **FORD TRACTOR DEALER**

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City-County Franchise Decisions

Leo T. Parker
Attorney at Law

When Franchise is Automatic

A reader has asked an interesting legal question: *Does a gas company, operating under a city franchise, automatically have a franchise in county areas that the city annexes?*

Also, this reader wants to know the legal solution when a gas company holds both a city and county franchise and the city annexes a part of the county.

Considerable discussion has arisen from time to time over the legal question: If two franchises, or contracts involving a gas corporation relate to the same relative area or territory, which franchise is permanent?

According to a leading higher court decision, if new territory is brought within a city, or annexed, the present ordinances of the city immediately and automatically become effective in the new, as well as in the old territory. This is so because the city's right to govern annexed territory is not based upon a contractual relationship with persons owning property, but is an attribute of governmental power granted by the Constitution and State to the municipality.

Therefore, where a gas company holds both a county and a city franchise, the court will imply that the county franchise contains a clause that automatically revokes the part of the franchise relating to the county territory annexed by the city.

For example, in the case of *Western Gas Company of Washington v. City of Bremerton, 153 Pac. (2d) 846*, the testimony showed that a gas company held two franchises. One franchise was given to the gas company by a city for the duration of 50 years. The other franchise was given the gas company by the county in which the city is situated, for a period of 25 years. The city franchise provided that the gas company must pay to the city 2 per cent of its gross annual revenue.

An important legal question presented the court was whether the city franchise automatically included county territory after its annexation by the city, and whether the gas company is obligated to pay to the city 2 per cent of its gross revenue from the consumers situated in the county territory annexed by the city. In holding in the affirmative, the higher court said:

"Obviously, the authority over franchises of this character cannot be exercised by both the county and the city simultaneously. The authority of the city supersedes that of the county upon annexation and thereafter the county franchise is terminated as to the new territory."

Gas Company Has Legal Right to Liens for Payment

A question which often arises is: Is a gas corporation entitled to a mechanic's lien on appliances that is permanently attached to real estate on orders from a tenant? Also, if the owner of a mortgaged building orders a gas company to install in the building gas appliances and devices, does the gas company have a lien on the building to secure payment?

The answer to the second question: **Yes, even without consent of the holder of a recorded mortgage to make installations, the gas company can perfect a lien on the real property.** However, a majority of higher courts hold that unless a gas company obtains consent of the mortgagee it does **not** have a first lien, but a secondary lien subject to the first mortgage. In other words, the higher courts very consistently hold that a properly recorded mortgage always is superior to any other lien, including a mechanic's lien, unless the contract of sale shows that the mortgagee expressly or impliedly consented to having the installation or repair work done.

A recent higher court held that "consent" of a mortgagee to making repairs on the mortgaged property is "implied" where the testimony shows that the mortgagee knew that the installations or repairs were being made and made no objection. See *Lincoln Corporation v. Morgan, 90 N. E. (2d) 522.* Here the testimony showed that a mortgagee saw a company's employee making certain installations and did not tell the company that he would not be responsible for payment.

In subsequent litigation, the higher court awarded the company a valid first mechanic's lien, and said:

"We think the evidence in this case was sufficient to show that the mortgagee consented to the making of the repairs and to the subordination of its lien. At the very least the mortgagee would be stopped from asserting a priority if he stood by in such a manner as to induce the serviceman to do the work."

For comparison, see *Harold Company v. Johnson, 103 N. E. (2d) 407.* Here the testimony showed that one Johnson was the owner of the property at the time of the installation of a gas furnace. One Alexander was a tenant who gave a written order for the installation of the furnace, and made all the necessary arrangements in connection therewith.

The company sued both Johnson, the owner of the residence, and Alexander, the tenant, to recover $404.01, the amount specified in the installation contract. The company based its suit against Johnson upon two theories of law: (1) implied agency, and (2) unjust enrichment.

The company introduced no testimony proving that Johnson had given his consent to installation of the furnace. In fact the testimony showed that the furnace was installed by the company at the instance of Alexander, without knowledge and consent of Johnson.

The higher court refused to hold Johnson liable, saying:

"We find no evidence from which an inference can be drawn to support the claim of an implied agency. This corroborates the testimony of the defendant, Johnson, completely and therefore the claim of unjust enrichment is wholly lacking in evidentiary support."

Convair solar furnace in action.

Industry Looks At SOLAR ENERGY

The energy of the sun is unlimited. Ever since the Stone Age, mankind has tinkered with ways to use it. But impatient Man found fire, electricity, fission and other things. The sun waits.

Today useful solar energy seems closer than ever—although big projects are far distant. In Phoenix weary executives tidied their records after the biggest world conference on solar energy. The six-day meeting was officially called a "symposium" which some erudite delegates insisted was a "Greek drinking party" (its original meaning).

Whatever called, the meeting was a great success. When the idea was born two years ago the boosters hoped to lure 400 delegates. Final registration was about 1000 aside from 70 newspaper and magazine writers. Delegates arrived from 35 countries on six continents. The global representation ranged from Algeria to Lebanon to New Zealand. Said former U. S. ambassador and program chairman Lewis W. Douglas: "I am amazed—and impressed."

Arizona is a superb spot for a solar conference. The state gets more annual sunshine than any of the other 47; in some places the sun is rated 91 per cent (sunshine days). Several years ago some Arizona boosters (perhaps irked by the hoop-la over atomic energy) decided to capitalize on their great natural phenomenon.

After months of plans they established the Association for Applied Solar Energy in March, 1954. Then they asked Stanford Research Institute to make a world-wide survey of possibilities. The pace quickened. Many hard months later they sponsored the recent World Symposium backed with the cash and efforts of such groups as the Ford Foundation, National Academy of Sciences, Rockefeller Foundation, U. S. Air Force, Office of Naval Research, UNESCO and National Science Foundation. Said one solar man: "This affair really starts us. Now all we have to do is keep it up."

Sun energy

Scientists like to talk about the sun with its tremendous mass (330,000 times the earth) and its unbelievable heat (up to 30,000,000 degrees). Ancient men worshipped their Sun God; modern man would like to put the sun to work. If ever effectively harnessed, the results could be astounding since on a summer day the sun can deliver the equivalent of 5000 hp an acre.

Not long ago two researchers named Ayres and Scarlott put it another way: it would take the sun only three days to outlast the complete combustion of all known earth fuels. And while earth fuels (coal, uranium or otherwise) are limited it takes the sun one billion years to lose an estimated 1 per cent. As one solar scientist expressed it: When the sun is gone, it won't make any difference."

Historical notes on solar energy go back many years. About 250 B.C. Greek inventor Archimedes repulsed an enemy fleet with fire rays from solar reflectors; many centuries later the sun powered a printing press at a Paris exposition; still later a Frenchman named Monchot perfected and patented a solar boiler.

Some of the early U. S. experiments were right in Arizona. While a few idlers jeered, a cone-shaped 700 sq ft collector generated 156 lb of steam pressure in Willcox in 1903-04; about the same time solar "extraction" experiments took place in Hardyville. In most cases the adventurers ran out of cash and enthusiasm before they developed anything of economic value.

Sun potential

Because they have so much sun and so little water, Arizona and several other Western states could use solar energy. One of the features of a "Sun at Work" exhibit at the symposium was a solar irrigation pump which noiselessly lifted water all day.

With scientific enthusiasm some sunstruck boosters carry the irrigation idea several hundred miles further. They envision a solar converter to make fresh water out of sea water (it can be done). Then solar energy would splash fresh water on the sun-dried desert and turn it into gardens. One big hurdle: money. In the symposium's headquarters in the colorful Westward Ho Hotel, one delegate remarked: "If we only had a tiny fraction of all those billions spent on atomic energy."

Despite the shortage of money, many things have been accomplished. The sun has supplied hot water to some U. S. householders for many decades (example: Florida). There have been attempts at a complete solar heated house but man has lagged behind the sun. One experimental home 40 miles outside of Tucson gets all necessary conditioning but it costs twice ordinary systems. There are a batch of solar cookers and boilers, many of which are

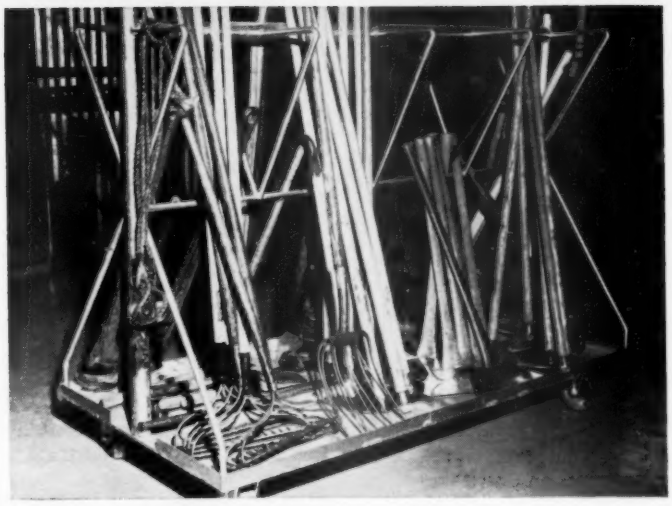
(Continued on Page 58)

This is reprinted from *Investor's Reader* for November 30, 1955.

IDEAS AT WORK

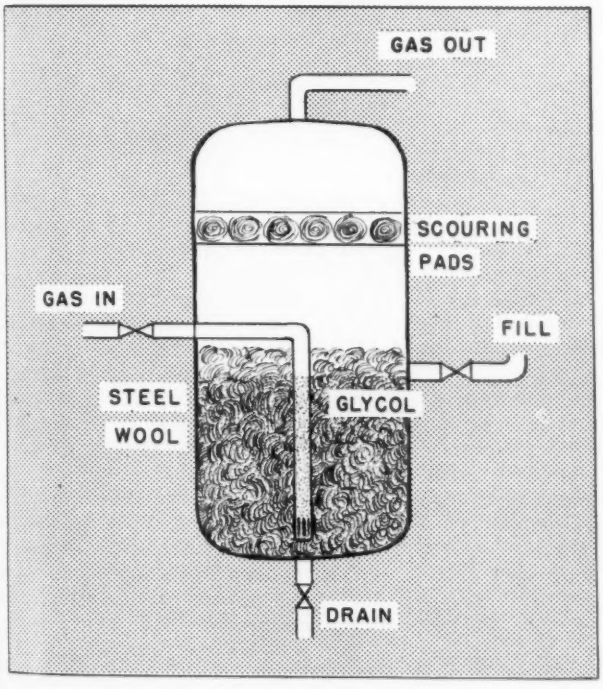
IN THE GAS INDUSTRY

YOUR IDEAS ARE WORTH MONEY!
If you have an operating idea or have devised a piece of equipment to do a job easier or cheaper, send it to us with a photo or drawing (we fix up rough sketches)... we will pay $10 for each idea used.



Portable rack for all sorts of tools. Everything but the kitchen sink can be stored on this handy cart made from scrap materials found around most junkyards. First, four casters off a worn-out dolly are welded to the bottom of a section of half-inch steel plate four feet by eight feet.

Two four-foot sections of two-inch pipe are welded upright on this base, one at each end of the platform. Between these two posts is first welded a length of two-inch pipe for the main bracing, then about halfway down the two posts another length of three-quarter inch pipe is welded. To this basic framework is added all the partitions you desire.



How to dehydrate and scrub instrument gas. Here is a dehydrator that will depress the dew point of gas some 60 degrees and scrub and clean it as well. It can be sized according to the amount of gas used and the moisture content. The dehydrating agent is glycol which will absorb 15 per cent of its weight in water before needing replacement or reclaiming.

The bottom half of the dehydrator is filled with steel wool and the inlet pipe is slotted to disperse through the steel wool and glycol before the gas leaves the vessel.

Cheater for stubborn valves. A field man reall won't be cheating when he uses this "cheater." He'll be saving wear and strain on his muscles. It gives him leverage that cracks open the most stubborn valve.

The cheater is fashioned from a steel bar 30 to 36 in. long with a curved hook bent in one end. The two prongs, 6 in. up the handle from the hook, are lengths of ½-in. steel rod welded to the bar.

Regulator Station Design and Ventilation

J. F. Schuldt

Peoples Gas Light & Coke Company

Chicago, Illinois

In 1953 a task group was appointed by the Subcommittee on Distribution Design and Development (of the AGA Operating Section's Distribution Committee) to study regulator station design and ventilation. It was thought that, if the practices of gas companies could be reviewed and reported on, some ideas on the different phases of construction might be helpful towards the improvement of present stations or in the development and the design for future construction.

The group as appointed, consisted of Marshall S. David, development engineer, Boston Gas Company; T. C. Wray, chief engineer, Nashville Gas Company; and John F. Schuldt, engineer of distribution design, The Peoples Gas Light and Coke Company, chairman.

At the time this group was formed, ventilation of regulator vaults had become an item of more than usual interest. Our first investigation therefore dealt with vault ventilation and an interim report on it was given at the Distribution Conference held in Montreal, Canada, in 1954.

The next step was accumulation of information pertaining to the design, construction, etc., of regulator stations. A questionnaire was sent out and over 80 replies were received from companies in 35 states and Canada, giving a good geographical coverage. A preliminary report was presented at the Cincinnati Distribution Conference in 1955.

During the period this group has been working, the American Standard Code of Gas Transmission and Distribution Piping Systems was completed. Section 849 covered the item of vaults and undoubtedly has or will affect the design of regulator stations. It would be well for the design engineer to familiarize himself with the several provisions in this section and use them as a guide in the future. A number of companies reported that changes would be made in their installations to conform to the code.

It has not been the intent of this group to make any specific recommendations. This report shows what is being done in general but, the final decision on any installation still remains in the hands of the individual company.

THE pattern by which mains are installed, their age, load distribution and density, geographical conditions, etc., play an important part in selecting a location for a district regulator.

Exposure to traffic, both pedestrian and vehicular, exposure to surrounding structures in the event of the operation of safety devices, location of vent stacks, if necessary, and conformance of structures to the appearance of surrounding property should be given careful consideration in the selection of the actual site.

It is generally agreed that private property would be ideal but for various reasons, such sites are seldom available at the most desirable vault location. The survey revealed that approximately 40 per cent of the stations were in parkway areas, 24 per cent in the street itself, 18 per cent in sidewalk space, and 18 per cent in private property. Over 80 per cent of the stations were made below ground. The majority of those above ground were generally situated at a company plant.

Some of the reasons expressed for the preference of the parkway locations are given as follows:

1. **Ease of access**
2. **More accessible for ventilation and operation**
3. **Better working area**
4. **Property rental or purchase unnecessary**
5. **Less subject to surface water flooding**
6. **Work performed outside of traffic hazard area**
7. **Less subject to interference from street widening or grading work**
8. **Less conspicuous**

Local ordinances do not, in most instances, restrict vault locations. A few companies reported that approval had to be obtained from specific governing bodies before a regulator station could be installed.

Size of Station

In the past it has been the practice to house all parts of a regulator station in a single structure. Now, with the trend towards the segregation of valves, regulators, safety devices, etc., smaller underground stations are being used. According to the code, ventilation of a vault is not required if the internal volume is less than 200 cu ft. (This provision does not apply in some states where ventilation of all underground structures is mandatory.)

A vault measuring 5 ft by 6 ft by 6 ft is within this limit and provides ample room for most equipment and servicing of this equipment, provided the valves are installed outside the vault. Because of its small size, it would appear that less maintenance would be required, vent stacks may be eliminated if desired, and, in areas of subsurface congestion, it would be less difficult to select a location for the vault.

A variety of over 20 different sizes of underground structures was reported as being in use at the present time.

Construction

Various forms of construction are used for regulator stations. The following tabulation will give some idea as to the preference of one over another for both underground and aboveground stations. These percentages are a summary of the totals reported in the questionnaire.

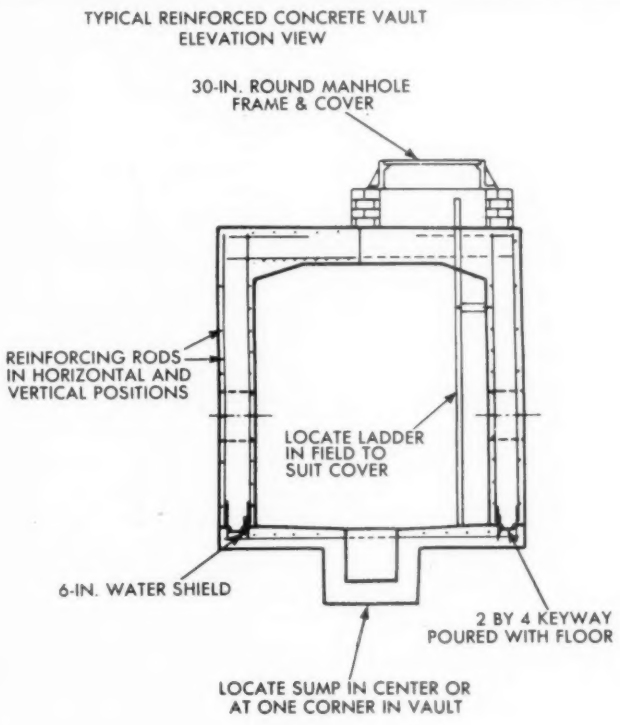

TYPICAL REINFORCED CONCRETE VAULT
ELEVATION VIEW
30-IN. ROUND MANHOLE FRAME & COVER
REINFORCING RODS IN HORIZONTAL AND VERTICAL POSITIONS
LOCATE LADDER IN FIELD TO SUIT COVER
6-IN. WATER SHIELD
2 BY 4 KEYWAY POURED WITH FLOOR
LOCATE SUMP IN CENTER OR AT ONE CORNER IN VAULT

FIG. 1.

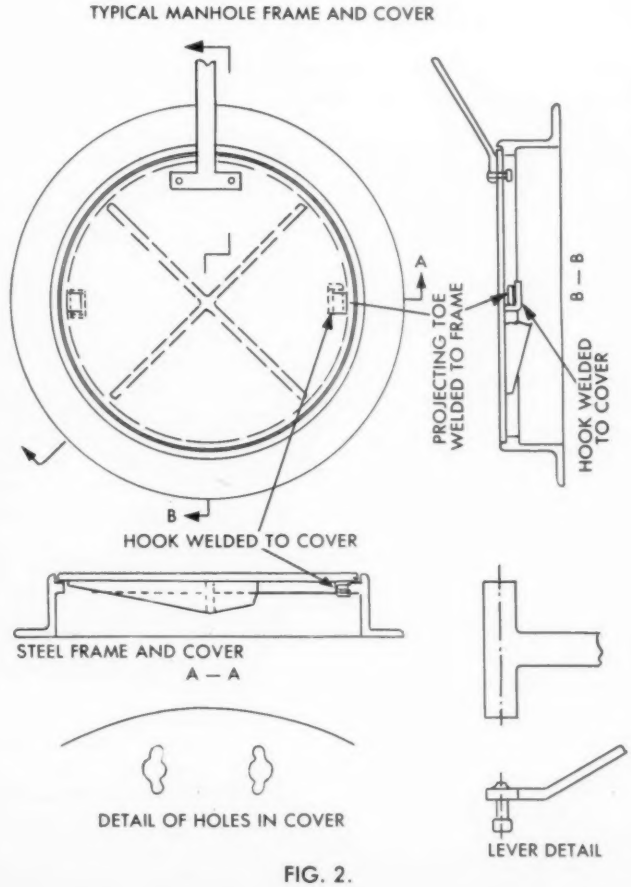


FIG. 2.

Type of Construction	*Underground Station*	*Aboveground Station*
Reinforced concrete	52%	3%
Brick	25	32
Cement block	5	10
Prefabricated steel	8	—
Sheet metal houses	—	31
Precast slab construction	8½	—
Wood	1	9
Open pits—guard rail barrier	½	—
Open shelter—roofed only	—	10
In open—no shelter	—	4
Other miscellaneous	—	1

As shown in the tabulation, the reinforced concrete vault is favored in underground stations. There is little doubt that a concrete vault, properly reinforced and waterproofed, makes an excellent structure. It is easily formed and, with the use of a ready mixed concrete, the pouring problem has been simplified. A 1-2-4 concrete mix is common for this type of vault.

Fig. 1 shows an elevation of a typical vault with some of the features which may be considered in the design. These may be adapted to any vault, regardless of the type of construction used.

Should there be doubt as to the structural requirements for design, or where local regulations do not specify structural limitations, the specifications as set forth in the code may be followed. Section 849.1, paragraph a, states in part that, "the roof slab or cover shall be designed to carry a 15,000-lb wheel load distributed over a contact area of the road surface 15 in. in diameter. The walls shall be designed to resist a uniform horizontal pressure of 250 lb per square foot without damage."

Because of increased interest in safety, load density, and the installation of larger sized regulators that could over-pressure a system, a greater use of monitor regulators and other safety equipment is being made. Gas companies are installing more vaults than heretofore and, therefore, are inclined to make a simplier type of structure than in the past.

The size of new vaults is also being reduced to avoid the need for providing ventilation. No decrease in the design strength of the new vaults should be tolerated because of the simplification and reduction in size.

In many instances, a station designed for parkway or sidewalk use is of much lighter construction than one designed for the street. It is true that a street vault is subject to much heavier loading, but what is there to prevent the accidental passage of a heavy vehicle over a parkway area? Failure of the lightweight vault as a result of a sudden overload could be serious. It

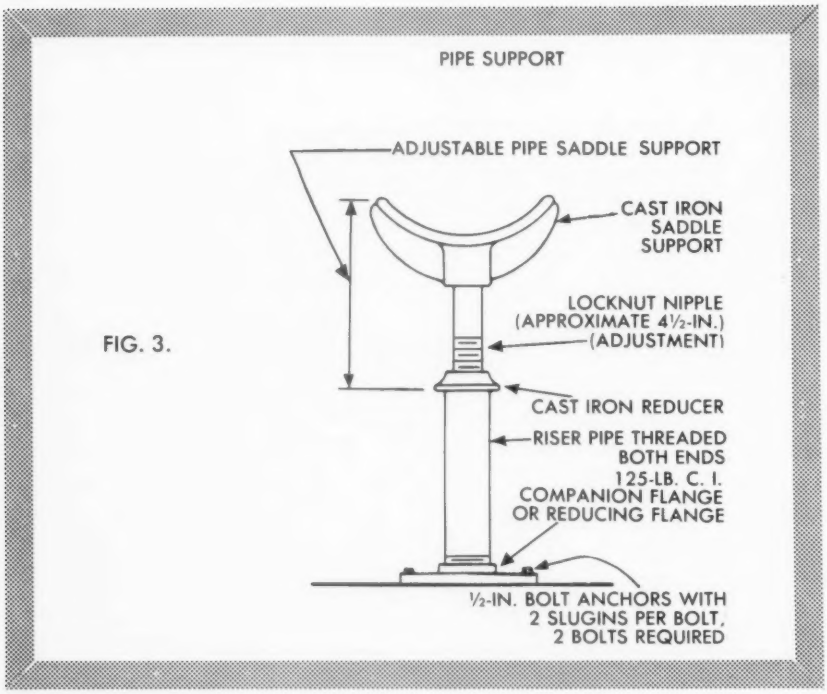

PIPE SUPPORT
ADJUSTABLE PIPE SADDLE SUPPORT
CAST IRON SADDLE SUPPORT
LOCKNUT NIPPLE (APPROXIMATE 4½-IN.) (ADJUSTMENT)
CAST IRON REDUCER
RISER PIPE THREADED BOTH ENDS
125-LB. C. I. COMPANION FLANGE OR REDUCING FLANGE
½-IN. BOLT ANCHORS WITH 2 SLUGINS PER BOLT, 2 BOLTS REQUIRED

FIG. 3.

has been the practice of some companies to install all vaults in public right of way designed for maximum load conditions. In using a smaller vault the difference spent in time and material in construction of a well designed structure as compared to a lightweight one becomes negligible.

Ample room should be left between the top, the roof and the ground level to allow for any alteration of the surface grade which may occur as the result of street paving, widening projects, regrading work, etc. If the frame of the manhole cover is equipped with a telescopic type of neck, adjustments can be made provided the vault roof is installed at the required elevation to permit the adjustment. A good cushion between the roof and pavement is also helpful in lessening the effect of the impact of vehicular loads on a vault.

It should be remembered that a regulator station should be designed to provide safe and desirable working conditions for personnel and with a view towards eliminating excessive maintenance costs.

Covers

Four types of covers primarily used on underground structures are the round cover; the square or rectangular cover; the full opening cover, which also serves as the roof; and the sectional cover, which, although it serves as a roof, may be opened in sections as desired.

The round cover is favored over the others by a large majority. There is no chance that a round cover will accidentally fall into a pit, as is possible with the square or rectangular cover. The maintenance of hinges, as is necessary on all hinged covers, is eliminated. The ASA code requires that whenever an opening is to be situated above equipment which could be damaged by a falling cover, a circular cover should be installed or other precautions taken.

Reactions to the requirement of locks on covers was indifferent. In most instances, the weight of the cover is assumed to be sufficient to prevent tampering. Some covers are bolted in place and locks are used on others. Fig. 2 shows a simple locking arrangement which may be adapted to any round cover. Shifting of the cover in a circular manner locks the cover in place.

Some use is made of a seal cover in the neck of the manhole. Its purpose is to seal off the vault as well as to prevent surface water or other debris from entering the manhole.

In selecting a cover, care should be taken to see that it is large enough to permit the passage of equipment and fittings for installation or during repairs, and to permit ingress and egress readily.

One or two covers are commonly used per vault. Some companies use a combination of a round and square cover. More than one cover is used by some companies to vent a vault quickly before entering it.

Drainage

With the abolition of sewer connections by the ASA code, the problem of drainage is limited to either a sump or crushed stone type of floor. Placement of the sump is a matter of choice but it should be placed in an accessible position for pumping and where it will give minimum interference with the maintenance of the equipment. A common location is the corner of the vault in back of the ladder.

A perforated cover plate may be supplied if the sump is located where someone may accidentally step into it. It is the practice of a number of companies to place the sump in the center of the floor where the additional space of the sump is used when overhauling regulators that have a bottom opening.

Some use is made of a suction line consisting of 1½-in. pipe extending from the bottom of the sump to the surface of the vault to permit pumping without removing the cover.

Ladders

Most ladders used are steel and are fastened permanently to the wall. A few companies reported using wood or aluminum ladders. It is felt that having a ladder fastened to the wall is good practice as it provides the only means of exit if an emergency arises. If a removable ladder is used some type of hanger or stop should be used to prevent it from slipping.

Pipe and Fitting Supports

Brick or concrete piers, pipe or wood supports or hangers from the roof are used to support the valves, regulators, fittings, etc., in the station. Although all of the types mentioned may serve their purpose satisfactorily, an adjustable pipe support may have some advantages (see Fig. 3).

This type of support may easily be removed while working on the equipment, or adjusted to proper height — whatever the need may be.

Painting

Opinion on the painting of the interior of the structure and piping for both aboveground and underground stations is divided. It is pointed out that better housekeeping conditions existed in painted stations. A good waterproofing paint, properly applied to concrete or masonry surfaces, also helped to keep underground stations drier.

Painting of the piping and equipment in a station will add to its appearance. Some companies use a color code in their painting. As an example, one company used the following color code.

Low pressure — green
Intermediate pressure — yellow
High pressure — red
By-pass lines — striped

Another company paints all inlet piping red and outlet piping blue.

With the additional control piping resulting from the use of safety equipment, the differentiation between the

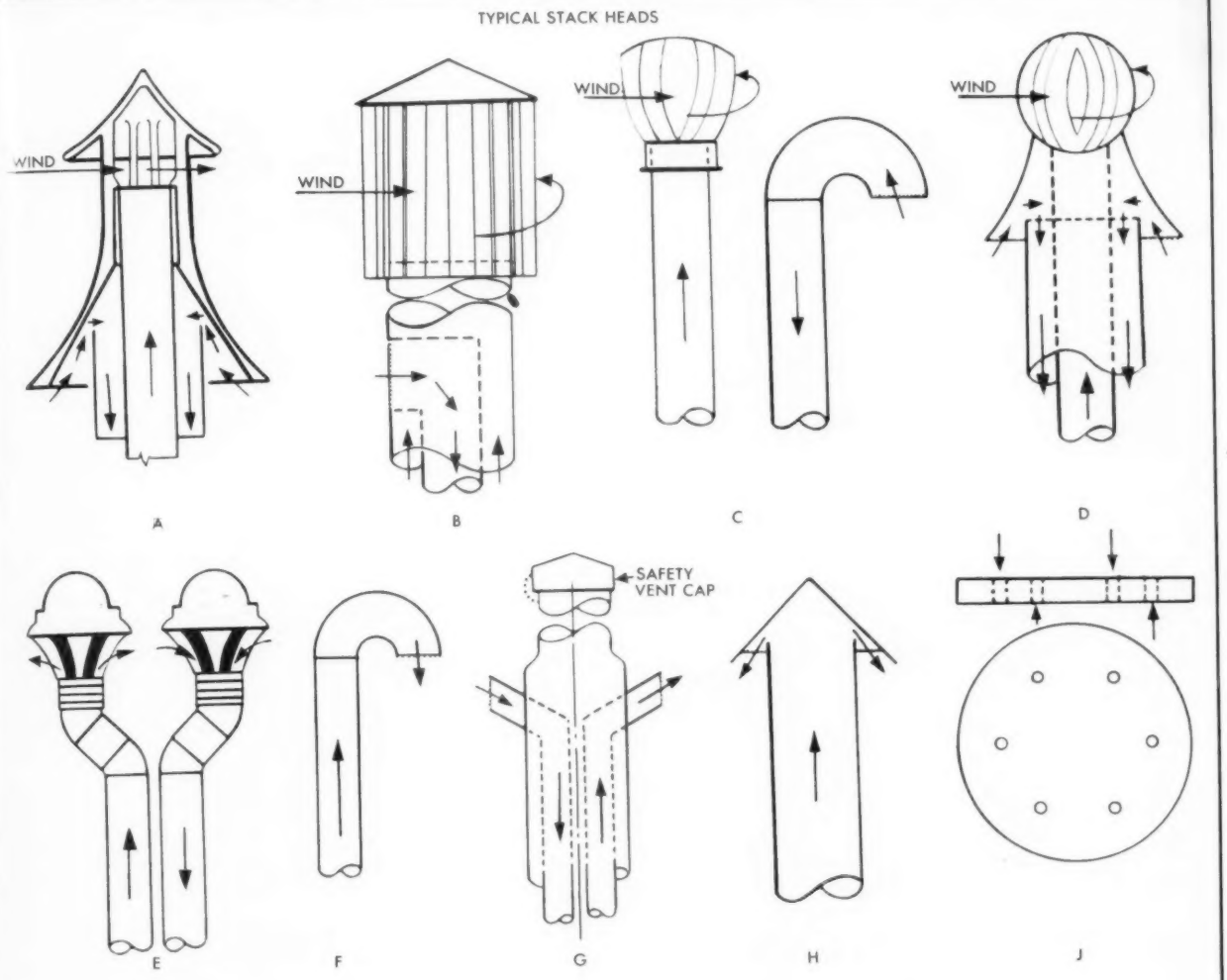


FIG. 4.

piping has assumed a greater importance. Color coding of the piping by companies not using such a system might be given consideration.

Wall Seals

It is important that the entry of piping through the wall in underground stations be sealed in a manner to help prevent the concentration of stresses on the pipe and prevent the leakage of moisture or gaseous products into the station. A preference was expressed for the use of sleeves in connection with masonry or concrete structures.

The sleeve, several inches larger in diameter than the gas main, is installed in the wall at the time of construction. The voids are filled with mastics, yarns, etc., and in some instances a reducing coupling is used. On steel vaults, the main is either welded to the wall or a coupling is used, with the center ring being welded to the wall and acting as a sleeve.

Where no sleeve is used, the wall is formed directly around the main, which has some type of wrapping on it.

Opinion is that strains, caused by vibrations, settlement, or other reasons, are minimized when a wall sleeve is used. Also, if the piping has to be adjusted or removed for any reason, it may be done without disturbing the wall structure.

Miscellaneous

Other miscellaneous items connected with station design may be briefly considered as follows.

Soundproofing. Little need for soundproofing of underground stations was found. Some use of it is made in aboveground stations but as it is usually a local problem it should be resolved by the individual company.

Protective barriers around stations. Only in aboveground stations or open pit construction were barriers used. They consisted of a simple pipe rail or wire mesh type of fence. In residential areas, grounds are landscaped to conform to the surrounding areas.

Electrical facilities. Use of electric equipment is covered in the code under Section 849.4, paragraph c, which states that electrical equipment in vaults shall conform to the requirements of Class 1, Group D, of the National Electrical Code (ASA C1). Electricity is used for lighting and in a few instances for control and equipment operation.

Cathodic protection. The application of cathodic protection is being given more consideration than in the past. More than half of the reporting companies make use of cathodic protection for piping and equipment around a vault. The additional use of steel vaults in recent years has added to this problem. The extent of all protection should be determined by the corrosion engineer.

Costs — There was a great variation in the cost of regulator stations. Prices ranged from a few hundred dollars to several thousand dollars, depending on the type of structure, size, location, etc. It is the responsibility of the design engineer to provide a structure that will be adequate for use at a minimum investment.

Ventilation

When the task group was formed, it was the intention to prepare a sug-

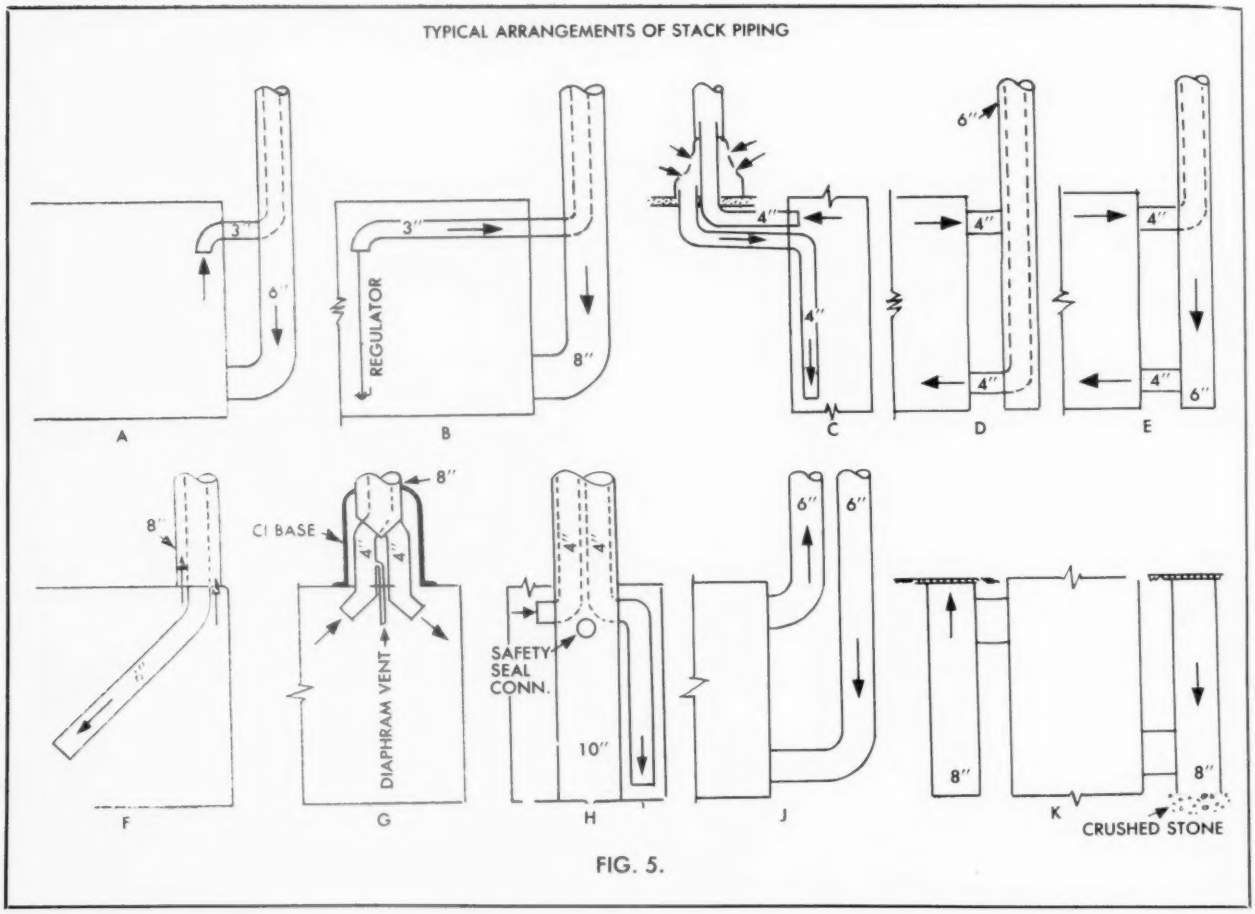


FIG. 5.

gested standard for vault ventilation. A review was made of the work and tests conducted by several companies and the U. S. Bureau of Mines on various types of vault ventilation. This part of the task was resolved through the adoption of the ASA Code. Section 849.3 covers the ventilation of underground vaults very thoroughly. Many of the problems and questions raised by various companies have been answered by the provisions in this section.

Briefly, it states that all vaults should be ventilated where the internal volume exceeds 200 cu ft. Two vent ducts are to be used and should be large enough to minimize the possibilty of formation of a combustible atmosphere in the vault. The ventilating effect of a pipe 4 in. in diameter was specified as the minimum-sized duct that could be used. Qualifications for the height of the duct and type of ventilating hood to be used are also given. Vaults having an internal volume between 75 and 200 cu ft need not be ventilated if all openings are properly sealed. Vaults with an internal volume of 75 cu ft or less do not require ventilation.

Questions were asked, at the time the questionnaire was sent out, as to the size of vaults being ventilated, location of vent ducts and objections encountered in connection with the installation of vent ducts.

Vent piping, where used, was either 4-in. or 6-in. in diameter. Many were combined into a pipe within a pipe as illustrated in Fig. 5, illustration G. To overcome the objection of the unsightly appearance of vent stacks, an ornamental standard of some type was used.

Fig. 4 shows the different stack heads presently being used by some companies. Simple heads are represented in F, H and manhole cover J. More elaborate rotating heads are illustrated in B, C and D.

Fig. 5 shows various arrangements of stack piping. Some companies using aboveground gage boxes run piping to this equipment in the vent stacks.

Complaints in better residential areas on the appearance of the vent stacks were overcome in some instances by using a higher vent stack. In other instances where complaints were made it was pointed out that the vents actually were not much different from the utility poles generally installed throughout residential areas. Other companies reported the necessity of having to obtain permission of the municipalities to make such installations.

Regardless of the type of stack used, care should be exercised to see that they are situated a reasonable distance from structures so no hazard from escaping gas will be encountered.

In most instances the opinion is general that the operation of existing vault structures would continue as in the past because the code was not retroactive. This does not imply, however, that any unsafe existing installation should continue in operation. New structures would be erected to conform to the various provisions of the code.

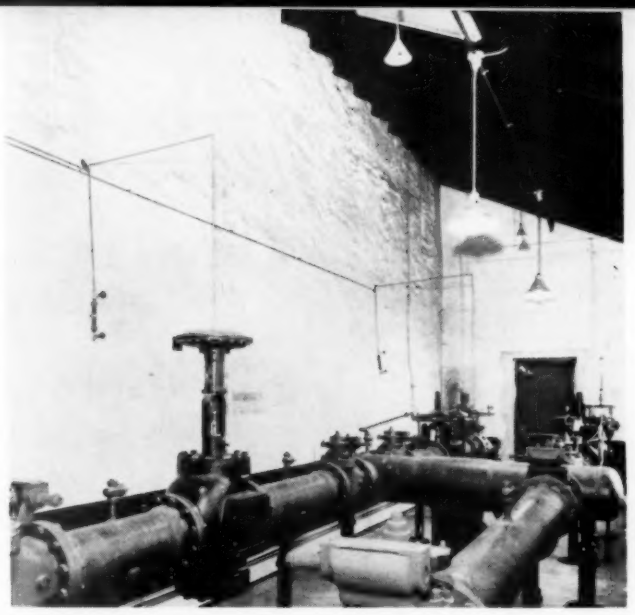
Safety

Safety of construction and operation should not be neglected. One reply received had this quite appropriate remark to make. "In discussing the design of underground pits, too much stress cannot be placed on the fact that each station is a problem in itself. Safety to the public and personnel, relationship to our distribution system, ground conditions and ease of maintenance must all be taken into consideration."

Insist on a good safe design. Provide the necessary tools and equipment in order that work may be performed in a safe manner. A good, regular inspection program will be a help towards accident-free operation. ★ ★ ★

"Silent Watchman"

Protects Automatic Regulator Station



Interior view at the automatic regulator station of the Philadelphia Gas Works. The small cone seen at the top of the photo, another is visible in the background between the lights, is part of the gas detection system. Cones collect samples of the atmosphere in the station and sound an alarm five miles away when combustibles are present. Due to the automatic alarm installation, personnel need visit the station only once each week to collect and replace charts in the recording apparatus.

INSTRUMENTS do all the work in detecting potentially dangerous gas leaks at a new automatic regulator station operated by Philadelphia Gas Works. The station's silent, mechanical watchman automatically reports any leaking gas to a control center five miles away.

The regulator station building replaces a large holder station that PGW previously maintained in the suburban section of Philadelphia. It is a concrete structure with two rooms and a basement. Gas for more than 14,000 customers in this area is controlled from here.

The station operates itself. Once every week, a PGW employee visits the building to collect the circular charts used to record gas pressures, and to place new charts in the recording apparatus. Aside from this, there is no need for personnel to spend much time at the station.

PGW management has also taken steps to keep hazardous conditions under complete control. In such a station, a gas leak could go undetected for several hours. To handle this problem, PGW has installed a combustible gas alarm that continuously samples the atmosphere in each of the building's three sections. If a leak should occur, a bell rings and a light flashes in the dispatcher's office, five miles from the station. Then, word is broadcast over the radio network and a PGW car proceeds to the spot immediately.

In the station, samples are drawn from four different points: two in the valve room, one in the instrument room, and one in the basement.

Here's how the alarm instrument works:

Samples of the surrounding atmosphere are drawn into the instrument and passed over one of two heated, sensitized platinum filaments which are a part of a balanced electrical circuit. The second of these filaments, the compensator, is sealed in a cell containing uncontaminated air. Any combustibles present in the air sample drawn over the first, the detector, filament will burn as soon as they come in contact with the heated wire. This increases the temperature of the filament and, consequently, its electrical resistance. The higher resistance of one filament upsets the balanced electrical circuit in direct proportion to the concentration of combustibles in the sample.

Degree of unbalance is measured by an indicating contacting meter, or relay, so designed that when the pointer is deflected to a preset mark, an electrical contact is closed, which in turn operates a double pole, double throw relay.

At Philadelphia Gas Works, the relay is used to open the signal-circuit rather than close it. The circuit, a leased telephone company circuit, that carries the signal to the alarm point in the dispatcher's office at maintenance headquarters is continuously closed unless something goes wrong.

When the alarm rings it means that there is a combustible present in the atmosphere at the station; that the telephone circuit has been interrupted somehow; or that there has been a power failure at the panel board where the alarm is mounted. Personnel immediately start to check all three possible causes, for PGW wastes no time in closing the circuit again.

PGW officials have solved a common problem with their new automatic station. Because of modern gas handling equipment, there is no need for continuous manpower at this regulator station, so workers are released for other duties. But in the time between visits to the station, a dangerous situation could arise if a leak did develop. The combustible gas alarm, PGW's mechanical watchman, makes this virtually impossible. ★ ★ ★

H. C. Missimer, assistant superintendent, engineering division, points to the reset button on the combustible gas alarm in the dispatcher's office of the Philadelphia Gas Works. The light immediately above the button, and a bell not shown, join in sounding an alarm when combustible concentrations are detected in the atmosphere of an automatic regulator station five miles away. The alarm system continuously samples the atmosphere in all three sections of the station, thus eliminating any delay in detecting a gas leak.

A CENTURY CLUB...

that demands a unique qualification — a cast iron pipe in service more than 100 years

THERE is one very limited club in the United States and Canada. A company has to be in the gas or water distribution business for 100 years or more to be eligible and even that isn't enough. It also has to have a cast iron underground pressure main that has been in active service not less than 100 years.

The Cast Iron Pipe Century Club was organized in 1947 with 18 members — this year there are 72, including the 4 Canadian members.

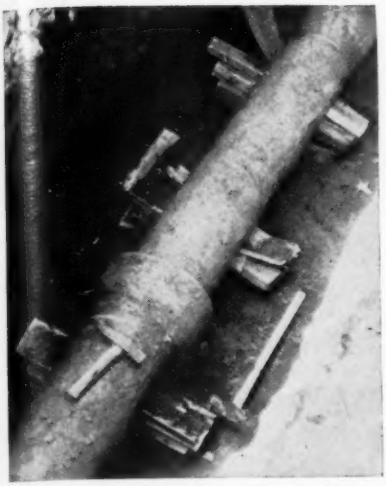
At present the club members are thick in the far East, with St. Louis and New Orleans as outposts. The great Western Plains and Rocky Mountain inhabitants were still carrying water in buckets for the most part. Sacramento, California, is the lone member in the far West. As the years go by, it will be interesting to see where the club members come from.

Philadelphia, Pennsylvania, claims the oldest cast iron pipe in use in the

This pipe, laid in St. Louis, Missouri, in 1831, is still in service.

MEMBERS OF CIP CENTURY CLUB

	Years of Service
Dept. of Water and Water Supply City of Albany, New York	105
Niagara Mohawk Power Corp. Albany, New York (gas)	104
Alexandria Water Company Alexandria, Virginia	105
Bureau of Water Allentown, Pennsylvania	140
Bureau of Water, Public Works Dept. Baltimore, Maryland	125
Consolidated Gas, Electric L&P Co. Baltimore, Maryland	140
Public Works Dept. Water Div. Boston, Massachusetts	109
Boston Consolidated Gas Co. Boston, Massachusetts	133
Public Service Elec. & Gas Co. Bound Brook, New Jersey	104
Bridgeport Gas Light Company Bridgeport, Connecticut	105
Dept. of Public Works, Water Div. Buffalo, New York	104
So. Carolina Electric & Gas Co. Charleston, South Carolina	118
Peoples Gas Light & Coke Co. Chicago, Illinois	105
Water Works Department Chicago, Illinois	104
Cincinnati Gas & Electric Co. Cincinnati, Ohio	101
Columbia Water Company Columbia, Pennsylvania	127
Board of Water Commissioners Detroit, Michigan	126
Michigan Consolidated Gas Co. Detroit, Michigan	103
Southern Indiana Gas & Electric Co. Evansville, Indiana	102
Fall River Gas Works Co. Fall River, Massachusetts	109
City of Frederick Water Dept. Frederick, Maryland	112
Frederick Gas Company, Inc. Frederick, Maryland	104
Gas Department City of Fredericksburg, Virginia	126
Public Service Commission City of Halifax, Nova Scotia	110
The Hartford Gas Company Hartford, Connecticut	107
Water Bureau of Metropolitan Dist. Hartford, Connecticut	102
Municipal Water Works Huntsville, Alabama	120
Citizens Gas & Coke Utility Indianapolis, Indiana	105
Bureau of Water Lancaster, Pennsylvania	121
Louisville Gas & Electric Co. Louisville, Kentucky	117
City of Lynchburg Water Dept. Lynchburg, Virginia	126
Natural Gas Service, Inc. Madison, Indiana	105
Municipal Authority of Minersville Minersville, Penn. (water)	101
Mobile Gas Service Corp. Mobile, Alabama	124
Mobile Water Works Company Mobile, Alabama	126
Quebec Hydro-Electric Comm. Montreal, Quebec	140
Public Works Dept. Water-Works Div. Montreal, Quebec	140
Pennichuck Water Works Nashua, New Hampshire	102
Waterworks Department City of Nashville, Tennessee	124
Public Service Electric & Gas Co. New Brunswick, New Jersey	105
New Haven Gas Company New Haven, Connecticut	109
New Orleans Public Service, Inc. New Orleans, Louisiana (gas)	121
Public Service Electric & Gas Co. Newark, New Jersey	110
Dept. of Water, Gas & Electricity New York, New York	132
Philadelphia Elec. Co., Gas Dept. Norristown, Pennsylvania	104
City of Painesville, Gas Dist. Dept. Painesville, Ohio	111
Central Illinois Light Co. Peoria, Illinois	103
Public Works, Bureau of Water Philadelphia, Pennsylvania	134
Philadelphia Gas Works Co. Philadelphia, Pennsylvania	121
Bureau of Water, Public Works Pittsburgh, Pennsylvania	106
Plymouth Gas Light Company Plymouth, Massachusetts	103
Pottsville Water Company Pottsville, Pennsylvania	122
Providence Gas Company Providence, Rhode Island	104
Quebec Power Company, Gas Div. Quebec, Canada	109
Bureau of Water Reading, Pennsylvania	122
Dept. of Public Utilities (gas) Richmond, Virginia	105
Dept. of Public Utilities (water) Richmond, Virginia	126
Rochester Gas & Electric Corp. Rochester, New York	103
Division of Water & Sewers Sacramento, California	102
Water & Sewerage Dept. City of Saint John, New Brunswick	112
Dept. of Public Utilities, Water Div. St. Louis, Missouri	125
North Shore Gas Company Salem, Massachusetts	106
Central Illinois Light Company Springfield, Illinois	103
Water Division, Dept. of Engineering Syracuse, New York	104
The Consumer's Gas Co. of Toronto Toronto, Ontario	114
Dept. of Public Works Troy, New York	111
City of Utica, Water Supply Utica, New York	107
City of Wheeling Water Dept. Wheeling, West Virginia	122
Wilmington Water Dept. Wilmington, Delaware	129
Water Department City of Winchester, Virginia	130
Water Department City of Winston-Salem, N. Car.	114
York Water Company York, Pennsylvania	116
Water Department City of Zanesville, Ohio	111



In New York City is the above cast iron pipe 126 years old.

Boston, Massachusetts, has this pipe in service since 1847.

United States — it was first laid 134 years ago. Boston, Massachusetts, has a 133 year old main in use and New York, a pipe 132 years in service. Montreal, in Canada, has an older record — 140-year cast iron pipe in service.

The table gives the names of the member companies, which can be municipal or privately owned, their location, and the number of years their oldest cast iron pipe has been in service.

The Century Club was organized by Thomas F. Wolfe, managing director of Cast Iron Pipe Research Association. Like nothing else could, the exclusive club points up the sturdy qualities of cast iron pipe. After all, when a product is in use from 100 to 135 years in 60 different towns, it is pretty obvious that it doesn't wear out easily.

It is an honor for the members who can show with modesty the Certificate of Membership in CIPCC, which indicates the company is not a fly-by-night organization either. * * *

Gas Reserves Reach Highest Peak

Recoverable reserves, at beginning of 1956, totaled 223.7 trillion cu ft — 1955 production was 10.1 trillion cu ft

PROVED recoverable natural gas reserves in the United States on December 31, 1955, showed the second greatest increase over the previous year of any year since 1945, when the American Gas Association began publishing official estimates. At the beginning of 1956, reserves reached a new high level of 223.7 trillion cu ft, an increase of 12 trillion cu ft over reserves of 211.7 trillion cu ft a year earlier, according to the joint report of the committee on reserves of the AGA and the American Petroleum Institute.

Extensions and revisions of previous estimates, and new discoveries of natural gas in 1955 once again exceeded production, which attained a new peak of 10.1 trillion cu ft. This record production of natural gas was about 700 billion cu ft more than the previous record of 9.4 trillion cu ft of natural gas used in 1954.

New discoveries of natural gas reserves in 1955 totaled 5.7 trillion cu ft, compared with 5 trillion cu ft of new reserves brought in during 1954. Extensions and revisions of previous estimates during 1955 added 16.3 trillion cu ft to reserves. Such extensions totaled 4.6 trillion cu ft a year earlier. Nearly 87.6 billion cu ft of natural gas were added to estimated reserves in underground storage during 1955.

The accompanying table gives a summary of the committee's annual estimates of proved natural gas reserves for the past 11 years, reflecting the changes in the natural gas reserve position in the United States during each of the 10 years since December 31, 1945.

The committee has continued the practice, begun in the report of December 31, 1948, of reporting the volume of gas in underground storage reservoirs. Since December 31, 1953, these figures have been based on data supplied by the Committee on Underground Storage of the American Gas Association. Prior to the report of December 31, 1953, the native gas remaining in a storage reservoir when injection began was classified and listed, for the most part, as a non-associated natural gas reserve and was not included in the underground storage fiigure.

Beginning with the December 31, 1953 report, all gas, including native and stored gas, is included in the underground storage figures. Adjustments in, withdrawals from, or additions to storage are included in the figures shown under the heading "Net Change in Underground Storage." Changes in underground storage are excluded from the column headed "Net Gas Production." Net gas production is the gross production from producing reservoirs less that gas returned to producing reservoirs in cycling and repressuring projects.

In view of the great diversity of pressure bases specified by different jurisdictions throughout the United States, attention is drawn to the fact that natural gas reserves esimates published in this and previous reports of this committee have been based on standard conditions of 14.65 psia and 60 F.

Summary of Annual Estimates of Natural Gas Reserves For Period December 31, 1945 to December 31, 1955 (Millions of cubic feet-14.65 psia, at 60 F)

	Natural Gas Added during Year						
Year	Extensions and revisions	Discoveries of new fields and new pools in old fields	Total of discoveries revisiotts and extensions	Net change in underground storage	Net production during year	Estimated proved reserves as of end of year	Increase over previous year
1945						147,789,367	
1946	*	*	17,729,152	*	4,942,617	160,575,901	12,786,535
1947	7,570,654	3,410,170	10,980,824	*	5,629,811	165,926,914	5,351,013
1948	9,769,483	4,129,089	13,898,572	51,482	6,007,628	173,869,340	7,942,426
1949	8,061,429	4,612,870	12,674,299	82,746	6,245,041	180,381,344	6,512,004
1950	9,172,381	2,877,351	12,049,732	54,301	6,892,678	185,592,699	5,211,355
1951	13,013,606	3,039,385	16,052,991	132,751	7,966,941	193,811,500	8,218,801
1952	8,934,470	5,411,043	14,345,513	198,850	8,639,638	199,716,225	5,904,725
1953	13,371,355	7,081,661	20,453,016	516,431†	9,238,540	211,447,132	11,730,907
1954	4,632,309	4,966,894	9,599,203	90,906	9,426,509	211,710,732	263,600
1955	16,298,125	5,719,069	22,017,194	8,637	10,118,118	223,697,445	11,986,713

* Not Estimated.
† All native gas in storage reservoirs formerly classified as a natural gas reserve is included in this figure.

Seventh of a Series

Communication:

How can we write superior business letters?

Dr. Dennis Murphy

WE'D be flabbergasted if a secretary came into our office, wearing hoop-skirts and button-shoes, wouldn't we? Yet our letter-writing may be as outmoded as old-fashioned clothes — without our suspecting it! Why not bring our letter techniques up to date, too?

Letter-Writing Is a Skill

We need special training in writing letters because business and industry impose special requirements upon us. Orders, sales solicitations, inquiries, complaints, adjustments — each has a different approach, its own appropriate vocabulary, and a special purpose.

A business letter often deals with some technical subject: A piece of equipment, some point of law, a manufacturing process, or some short cut to economy. The writer must be able to make his reader understand quickly and correctly even while reading on the run. Knowledge of technical terms, with the ability to use them clearly, is a skill that has to be learned.

Millions of dollars are lost annually in the oil business alone because of poor letters. And it's the same in other businesses. One of the Hoover Commissions in 1955 estimated that our federal government alone could save $75,000,000 each year by becoming more efficient in its correspondence!

Short, Clear, Friendly Letters

1. **Get the job done quicker (primary aim)**
2. **Stimulate business**
3. **Build public goodwill**
4. **Promote private morale**
5. **Make friends everywhere**
6. **Make letter-writing easier**

Letters are indispensable tools in carrying on most business. Good letters are a vital asset and superior ones yield big dividends. So, the time and effort spent to improve these tools will bring greater profit from an increased volume of business and improved attitude toward the firm.

Yet all this can never be done by condescending or talking down to a customer, by using exaggerated and insincere soft soap; by bragging, sermonizing, or name-calling; or by using words that antagonize a reader. One single antagonizing word can ruin an otherwise fine letter. And one bad letter-writer in a company can undo the work of about 50 good ones!

10 Commandments for Better Letter-Writing

Many excellent books and articles are appearing to help us improve this skill, yet there is so little that's new on so old a subject. This article offers little except common sense. It merely tries to jog your memory with 10 commandments for superior letter techniques. Here they are:

1. MAKE YOUR LETTER LOOK ATTRACTIVE

Frame it with plenty of white space, balance it with equal margins on both sides, and center it with about the same space at top and bottom. Double spacing is used for very short letters, but single spacing on smaller-size paper looks better.

Too many letters look top-heavy without any reason. Place the body higher if there's a long list of those to receive carbon copies, and break this list into several even columns across the bottom of the letter to improve its appearance.

If the letter is short, widen both margins — and lower the identification line a couple of spaces. If the letter is solid (hard for human eyes to dive into!), break it up into several short paragraphs.

Use every device to make your letter easy on your reader's eyes!

2. KEEP IT SHORT

Why tire any busy person with needless words? Tell him exactly what he wants and needs to know; then end crisply without any recap. First, set up your main purpose; then treat its parts in order — without any repetition. Make every word count.

Try to hold your letter to one page because it's easier to read and file, but an occasional letter that runs over 300 words will look better on two pages — or more. An experienced stenographer can estimate a letter's length from the space it takes in her notebook.

Here's a letter that turns brevity into an asset — understatement:

Dear Subscriber:

Ahem!

Cordially,
THE PETROLEUM ENGINEER

Royal Courtney

Royal Courtney
Circulation Manager

(Your subscription has EXPIRED)

3. MAKE EACH LETTER AN INDIVIDUAL TALK

In other words, be natural — just talk! Let your personality and character carry over into the letter you tailor-make for each individual. Even in form letters this can be done to a certain extent.

Never write to a blank wall — but to somebody. Imagine your reader seated across the desk from you; then write or dictate the kind of letter *you'd* like to receive. Make him feel that he's important (for he really is!) and that he comes first.

This is sound psychology. The psychological word for it is *empathy*, or "objectively putting yourself in someone else's place." Empathy is not a sentimental emotion; it is a mental appraisal. And the real secret of effective letters, or communication of any other kind, is this Golden Rule!

In addition to using imagination, here are minor ways to humanize your letters:

1. Use the first person (plural *we* or singular *I*) rather than the third person *it* as your subject. Except for formal communications, this is the natural, democratic way of saying things. When a manager writes "*We* recommend" instead of "*It* is recommended," he honors all those in his department who have anything to do with the research.

2. Use contractions and earthy colloquial expressions. People like them because they make you sound a lot more human.

3. Begin your sentences now and then with *And, But, Yet,* or *So.* The Bible is full of such sentences; so they're reputable.

4. End your sentence with a preposition if it's the right word to end with. Your word order should always sound easy and natural.

5. Use a short, fitting quotation now and then — if you can do it without sounding bookish.

4. EMPHASIZE THE Y-O-U ATTITUDE

Since every letter is a sales letter, our reader is our "customer"; he wants to feel valuable, needed, wanted. Everyone in the world is hungering for this tiny consideration. Yet how many letter-writers (even some supervisors and managers) blow about what *they* have done — while they tacitly tear down the other fellow and belittle his effort! Why frustrate a man?

Permit me to digress. "To reduce man to nothing," wrote Dostoevski, "give his work the character of uselessness." Nothing annihilates a man quicker than to depreciate his efforts and ignore his capabilities.

Human relations in business has one main purpose: To make employees feel this important sense of usefulness — of being necessary and wanted. Its goal is to make life more fun by making work more meaningful. There is nothing more paralyzing to either men or machines than disuse.

An application letter is one of the most important a man can write; yet most applicants fail to show *how* they can help, fit into, or benefit the firm they want to work for. Each writer is too busy tooting *his own* horn to consider his future employer! No empathy. Selfishness. To find ourselves, we must first lose ourselves — in working, thinking, living for others.

Years ago we were taught never to begin a sentence with the pronoun *I*. That's a lot of hooey, of course, but overuse of the big-I will bore others. So, play yourself down; play your reader up. Tackle each problem-letter from your reader's point of view first.

"Thank *you* for *your* letter of June 20" is better than "*I* have before *me* your letter of June 20." And "*Your* account will receive prompt credit if *you* send a duplicate invoice" is better than "To help *us* keep *our* records straight please send *us* a duplicate invoice."

5. USE THE POSITIVE APPROACH

Let's take the negative out of our letters and strike a positive attitude. This may require a change in our mental outlook, but it will pay big dividends. Instead of "*Unfortunately* we *cannot* ship until May 12," say "Your shipment will go out *promptly* on May 12."

Instead of saying "We *fear* your plan will *never* work," let's say "We *hope* a more *feasible* plan can be found." And instead of saying anything so negative as "We're *sorry* we have *no* opening and we *cannot* consider you," we can use positive words something like these: "Your application is on file, and you will be considered when (if) an opening occurs."

Sometimes our letter *has* to be negative—a refusal or turndown letter. But there's no excuse for its being a blunt slap in the face. We can always say *no* firmly but gracefully and make even our refusal build more goodwill and respect for our company. How do we handle this letter-in-reverse?

1. Thank the writer for his letter.

2. State that his request has been carefully considered.

3. Mention something good about it—any point of agreement.

4. Soften your refusal by saying we wish we could, but —

5. If it's necessary, tell honestly *why* we can't comply. And we shouldn't duck behind "company policy," "new regulation," or similar phonies.

6. Try to end on a constructive note by showing our interest in the request, hoping we can be of future help, or suggesting something else we might do. But let's not fall into a trap here!

6. CALL YOUR READER BY NAME

Despite its merits, the simplified letter recommended by the National Office Management Association has yet to win widespread acceptance. Undoubtedly one reason is the absence of a warm salutation in it. People like to be called by their names; so stay away from *Dear Sir, Dear Madam,* or *Gentlemen.* Instead, say *Dear Mr. Wilson, Dear Miss Barnett,* or *Dear Jack*—whenever you can.

One friendly touch comes when we address our reader again, but not more than once, in the body of our letter. Something like this near the end: "If you need more information, Mr. Wilson, please write me." Try it!

But we have to use impersonal salutations in letters to firms where no person's name is known. Even when we mention someone in the attention line, we do not address him but the one named in the inside address. It's friendlier to name someone in the inside address whenever we can, but official business takes place between firms.

Using an attention line but addressing the company is necessary in our fast-changing world (1) to keep business rolling if the attention-line man is on leave or vacation, and (2) to hold business if the attention-line man should leave the company.

7. WATCH YOUR OPENING SENTENCE!

Since your first impression is important, make your place kick a good one. Your kickoff in the first 20 words sets the tone of your entire letter. Attract your reader by saying something gracious, interesting, or arresting.

Most businessmen try to do too much in this opener; often they rehash the whole letter they're answering. This gurgitation and regurgitation of familiar matter is the biggest nonsense in business letters. Why tell a man something he already knows or his files will show? If a subject line is used, one specific detail and the date should identify what we're talking about. Then we can do one thing: state our aim quickly.

Here's an old-fashioned letter that breaks every rule in the book — it starts with a weak participle, restates what the inquirer well knows, repeats every detail he mentioned, and buries the purpose so deeply a detective couldn't find it.

Dear Sir:

Referring to your letter of May 15, 1956, in which you state that you would be interested in receiving complete information if it is available concerning the Group Hospitalization and Surgical Benefits Plan adopted by our Company for all employees and dependents, as amended on March 1, 1955:

Since you are considering the adoption of a similar plan in your company if it receives official approval of your Home Office, we are enclosing the booklet describing our Plan in detail which we think you will find of value and have also requested our Mr. Charles Black, Industrial Relations Manager in your city, to call upon you.

Yours truly,

Dear Mr. Wilson:

Thank you for your letter of May 15 expressing an interest in our Group Hospitalization and Surgical Benefits Plan. We're glad to send you complete information about it.

You'll probably find the enclosed booklet helpful because it describes our Plan in detail.

We have also asked Mr. Charles Black, our manager of industrial relations in Ft. Worth, to offer his services to you. He's well equipped to answer any questions you may care to ask.

If you need any further information, please don't hesitate to call on us.

Sincerely yours,

dm:ld
Enclosure
cc: Mr. Charles Black

In the revision the writer shows that he's a polite human being instead of a doddering parrot, that his firm is friendly and helpful, and that it has a fine regard for its employees. If you were the Fort Worth manager, how would you feel about the second letter? You'd probably never see a carbon of the first, but you'd get a formal order coldly requesting you what to do—without any explanation. What a difference in communications!

8. DEVELOP YOUR LETTER STEP BY STEP

Nothing reveals an orderly mind more clearly than a logical letter. A sense of organization comes when we (1) state our purpose in the very first paragraph and (2) develop each related part in order. We should begin a new paragraph for each new part or subhead, treating it fully before we tackle another.

If we make our letter "move" in natural sequence, we avoid repetition, overlapping, and backtracking. And our reader gets an inner satisfaction in feeling the subject unfold while he reads. What a joy to receive such a letter! Every fact and every needed detail are there; all we have to do is—act.

Points that we originate we should treat in the order of their importance; we should answer points or questions in the order they are asked. Often we can combine two or three related points, and we can underline or number our points to emphasize them and assure easier reading. If we give the correct and complete information wanted, we cut out expensive follow-up letters.

One suggestion: if we pencil rough notes in the margin of a letter before answering it, we help to crystallize our points into well-organized paragraphs. By numbering these, we can come up with a logical outline!

9. SPECIFY A DEFINITE DATE—A DEFINITE ACTION

We should tell our reader the *exact date* we will do something or expect him to do something. This is called *dated action*. "As soon as possible" is as good as nothing. How early is "at your earliest convenience?" When is "in the near future?"

Setting a definite date in your reader's mind will quicken his response and cut correspondence costs. "Please answer by airmail before June 1" is definite. If we know a reader is likely to be slow, we can set the deadline a bit earlier.

Again, we should decide on the *one action* we most desire if there are several alternatives. If we tell our reader to do this, or that, or the other—we only confuse him. This is called *divided urge*. And the chances are, nine times out of ten, he'll do nothing.

"Please let us receive all April orders by letter on May 5, or by wire before May 10—or, at the latest, by telephone on May 15." This kind of direction is sure to cause confusion. Better say: "Please wire all April orders to us before May 10."

10. WATCH THAT FINAL SENTENCE!

Sometimes we need to make it a clincher that carries zip and punch. Or make it action-compelling. Or simply courteous and appreciative. But no matter what we want our last sentence to do, we must make it ring true and honest. Knowing when to stop is an art; a brief closing is also a strong one.

A one-line sentence as a single paragraph gains tremendous emphasis: "Thanks for your cooperation on this project." "How about a letter by May 15?"

When we want favorable action from our reader, we can use persuasion to bring the desired result. Instead of "hoping" or "trusting" or "thanking you in advance," we can use some legitimate lure—without obvious pressure:

"Don't write a letter—just initial this form and mail it today.

"You'll maintain your high credit rating by sending a check today."

"We'll be glad to hold your reservation—until May 25."

"May I have an interview before June 10? Thank you."

Here are a few tips on parting sentences.

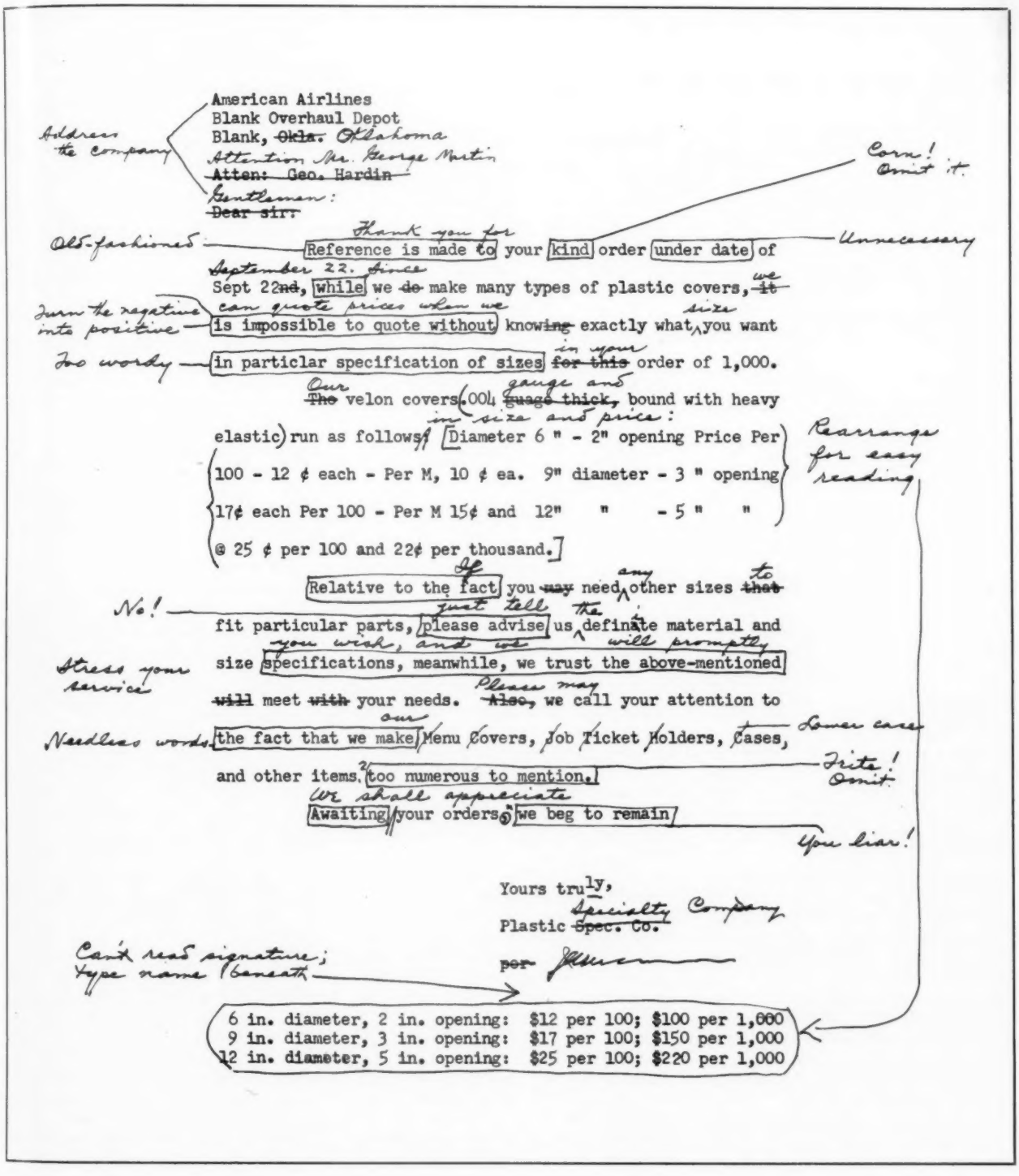
1. **Avoid the old-fashioned participle sentence, because non-finite verbals are never *strong* and *decisive*.**
2. **Stop when the letter's job is finished—keep it *concise*.**
3. **Use a one-line paragraph if you want it *emphatic*.**
4. **Never be curt; always be *courteous, complimentary*.**
5. **Suggest one definite action to make it *compelling*.**

PS: Careful planning of a letter makes any postscript seemed tagged on, if not helter-skelter; but this afterthought is sure to catch attention. Travel here at your own risk!

Letters Reveal Character

Surely we must conclude that good letter-writing is far more than the mere writing of routine words. On the contrary, it draws upon many facets of our knowledge and being. First of all, it involves our practical common sense, or plain old horse sense, combined with a careful regard for the Golden Rule in business.

A superior business letter involves our tact and good manners, our sense of sound ethics and moral obligation. In addition, it involves our accurate knowledge of human psychology, our powers of persuasion, our sense of honest sales


American Airlines
Blank Overhaul Depot
Blank, Okla. Oklahoma
Attention Mr. George Martin
Atten: Geo. Hardin
Gentleman:
Dear sir:
Address the company
Thank you for
Reference is made to your kind order under date of
September 22. Since
Sept 22nd, while we do make many types of plastic covers, we it
can quote prices when we
Turn the negative into positive
is impossible to quote without knowing exactly what you want
size
in your
Too wordy
in particlar specification of sizes for this order of 1,000.
Our
The velon covers (.004 gauge and gauge thick, bound with heavy
in size and price:
elastic) run as follows: Diameter 6 " - 2" opening Price Per
100 - 12 ¢ each - Per M, 10 ¢ ea. 9" diameter - 3 " opening
17¢ each Per 100 - Per M 15¢ and 12" " - 5 " "
@ 25 ¢ per 100 and 22¢ per thousand.
Rearrange for easy reading
If
Relative to the fact you may need any other sizes to that
No!
just tell the
fit particular parts, please advise us definate material and
you wish, and we will promptly
Stress your service
size specifications, meanwhile, we trust the above-mentioned
Please may
will meet with your needs. Also, we call your attention to
our
Needless words
the fact that we make Menu Covers, Job Ticket Holders, Cases,
Lower case
and other items, too numerous to mention.
Write! Omit
We shall appreciate
Awaiting your orders, we beg to remain
You liar!
Yours truly,
Specialty Company
Plastic Spec. Co.
per
Can't read signature; type name beneath
6 in. diameter, 2 in. opening: $12 per 100; $100 per 1,000
9 in. diameter, 3 in. opening: $17 per 100; $150 per 1,000
12 in. diameter, 5 in. opening: $25 per 100; $220 per 1,000
Corn! Omit it
Old-fashioned
Unnecessary

manship, and some acquaintance with law and the legal aspects of correspondence contract and libel.

Robert Louis Stevenson, himself a marvelous letter-writer, says that "conduct is three-fourths of life." And we profit from a periodic review of our letter-writing performance. To summarize, a superior letter reflects our character as well as our writing ability.

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Unaccounted-For Gas:

Where does it go and how can these losses be prevented?

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UNACCOUNTED-for gas is generally thought of in terms of leakage losses in the underground distribution system. This, however, accounts for only a portion of the gas losses. To disregard the other contributing factors only penalizes the underground structure.

How much of the unaccounted-for gas may be ascribed to actual leakage and how much may be ascribed to other factors depends upon the condition of the distribution system and upon the conditions contributing to the losses due to other causes. Unaccounted-for gas is an unavoidable evil, but while it may be unavoidable, it certainly can be minimized.

Escaping gas is a potential danger and any reduction in the amount of unaccounted-for gas, from any cause whatever, creates not only a monetary saving but is also a source of additional revenue.

Each company has adopted some arbitrary standard by which to judge the condition of a system. Is this standard serving as well today with new huge space heating and industrial loads as it did when first adopted?

The problem of unaccounted-for gas is a serious one, not only because of the high cost of the gas and from the angle of public safety, but there is also the problem of maintenance.

The amount of money spent in the past and that is continuing to be spent needlessly even today, through misdirected maintenance efforts, cannot be calculated. Were more facts made available, the maintenance efforts could be made much more effective.

$100,000,000 Annual Loss

In recent years the quantities of unaccounted-for gas have reached astronomical proportions and each cubic foot of it must be bought and paid for. With the increasing costs of gas, the prices paid for such losses are staggering.

Gas sales to ultimate consumers by utilities and pipe lines were recently reported as 6,696,470,000 Mcf. A 50 per cent average unaccounted-for figure is considered conservative. This results in an estimated 334,823,500 Mcf of unaccounted-for gas, which, if purchased at an average price of 30 cents per Mcf, amounts to $103,795,300 a year. This is a recurring cost and it might be well to determine what contributes to this annual waste.

No comprehensive study of unaccounted-for gas has been made and presented before the American Gas Association since 1911, when J. D. von Maur made a study of the causes of unaccounted-for gas. Von Maur's list of 26 items may be boiled down to perhaps 9 basic items. Some of these items are no longer applicable, but in their stead other sources of unaccounted-for gas have come into existence.

Recognition of these hidden losses, their magnitude and their cost to the industry can help operating men and management plan and channel efforts to reduce the unaccounted-for gas and determine the extent of maintenance programs along such channels. Properly conceived, economic and safety studies can be of great value in directing maintenance efforts.

Task Group Studies Problem

A task group consisting of J. H. Glamser, Oklahoma Natural Gas Company, J. S. Janssen, New Orleans Public Service Company and the author has been investigating the factors contributing to unaccounted-for gas and evaluating these factors.

The material being presented here represents only a light sampling and the figures quoted are in no way conclusive. Each system, each city, each town and even an area presents its own problem and this study can only point out the need for a local study, and support the objectives to be accomplished.

The material upon which this article is based was obtained through a questionnaire submitted to a group whom it was felt were in a position to supply the more detailed information. While all of the questionnaires were not returned, a sufficient number were returned to establish certain patterns that supply much food for thought. It has been recognized that local conditions affect the intensity of the pattern for any particular situation or for any individual company. Consideration must be given to this fact in applying these remarks to individual situations.

The Problem:

Unaccounted-for gas may be considered that portion of the gas purchased or manufactured that is not accounted for by sales, transfer, company use, or other uses.

Most companies report unaccounted-for gas in cubic feet, and as a percentage of the sendout. This provides a very elastic yardstick with which to judge the condition of a distribution system. For example —a manufactured gas system with a 5 per cent unaccounted-for figure converts to natural gas and the sendout increases tenfold.

If a 5 per cent unaccounted-for figure is maintained, the quantity of unaccounted-for gas will be 10 times as great for practically the same system. Fortunately, all this increase is not leakage or we might find ourselves unable to live with it.

How Reported?

Some companies report their unac-

counted-for gas in cubic feet per 3-in. equivalent mile of main. At one time when gas sales were relatively small this was a more realistic method of reporting unaccounted-for gas than reporting a percentage of the total sendout. Changing conditions due to large average gas sales have altered this situation.

Reporting unaccounted-for gas as a percentage tends to minimize the seriousness of large quantities of unaccounted-for gas and reporting it in cubic feet per 3-in. equivalent mile can make the distribution system look worse than it really is. Somewhere in between lies the correct answer.

Reporting the portion of gas due to causes other than leakage on a per meter basis, reporting the portion due to main leakage on a 3-in. main equivalent basis, and the portion due to service leakage on a 3-in. equivalent basis, might present a more realistic picture.

At the present time, probably no company keeps records that differentiate the losses due to the different factors contributing to the unaccounted-for gas. For the purpose of approximating these losses, a different approach to the problem must be devised.

Standards Needed

Before intelligently considering the factors affecting unaccounted-for gas, everything must be reduced to the same standard. It is impossible to evaluate any factor by using two standards of measurement. At present there are two yardsticks with which to measure the gas: correct the gas to a 60-deg, 30-in. base to report the sendout, or meter the gas at the existing atmospheric temperature pressure to report the sales.

The method of metering gas at the consumers' premises cannot be changed. In order to account for every cubic foot of gas volume sent out, the sendout must be reduced to the same basis.

The reason for this is quite obvious when we realize that companies operating at high altitudes may show a negative unaccounted-for every month.

For the purpose of uniformity in pipe line billing and for determining the operating efficiencies of a manufactured gas plant the gas should be corrected to some set standard. The temperature-pressure standard for manufactured gas is usually 60 F and 30-in. Hg. pressure. In calculating the amount of gas delivered to a distributing company by a pipe line company some arbitrary pressure is adopted.

A review of a number of pipe line tariffs at hand shows them all to be corrected to 60 F but the pressure bases vary as follows:

	30-in. Hg.
	14.65 lb abs.
	14.73 lb abs.
	14.90 lb abs.
	15.025 lb abs.

No change in the present method of reporting the unaccounted-for gas, or any change in the method of calculating it is suggested. The present method serves a purpose and appears to serve it adequately. The present method of reporting sendout, however, is misleading if used as a guide in studying the unaccounted-for problem.

Unaccounted-for gas studies, however, should have a method that will determine the actual difference between the actual volume of gas leaving the plant and the actual volume metered at the customers' premises.

Formulas are available that will permit calculating the actual volume of dry gas being sent out from the plant for different temperatures, delivery pressures and elevations. Charts with a limited range are available and may be used as a basis for calculating the volume of saturated gas. Where daily station meter readings are available, a more accurate figure may be obtained by applying the correction for the daily barometric reading.

Once the actual volume of unaccounted-for gas is obtained, the next step is to determine where it is going and in what quantities. After making such an analysis it is possible to determine where maintenance time and money may be spent to the greatest advantage.

Making More Exact Studies

Suppose meter shop tests show a company's meters to average 2 per cent slow. Obviously, then, the loss due to slow meters is 2 per cent of the annual sales, which loss we shall call X-Mcf. For the mythical company we show a 5 per cent unaccounted-for loss, which means that 40 per cent of the unaccounted-for can be charged to slow meters.

In our analysis we find that the correction for true barometric pressure adds 3 per cent to the gas sendout. This would result in a total unaccounted-for of 8 per cent, but the quantity of gas unaccounted-for due to slow meters would remain unchanged. The percentage of the total unaccounted-for gas chargeable to slow meters then becomes 25 per cent.

Losses at the residential customers' meters	**20.6%**
Losses at commercial customers' meters	**1.7**
Theft	**.7**
Main Leakage	**39.8**
Service Leakage	**16.0**
Other Losses	**21.0**
	100.0

The difficulty in separating two types of unaccounted-for gas becomes a problem. Perhaps we may never develop a technique that is perfect, but thought, experience and ingenuity can develop methods that will be better than ignoring the situation entirely as is done today.

What Can Be Done?

The following thoughts are being presented to stimulate thinking toward devising methods of determining the actual quantity of unaccounted-for gas and by the process of elimination and judgment arrive at a reasonable approximation of the amount of loss due to the different factors contributing to such loss.

As stated before, the method of metering gas at the customers' premises cannot be changed, so that must be the basis for all unaccounted-for studies. The proper factor should be first applied to the purchased or manufactured gas to bring it to the same basis as the gas sold. The most accurate means is to apply daily ground temperature and barometric factor to the daily sendout. Allowance must be made for the metering pressure of the gas. This will give the actual volumetric quantity of gas sent out. Further refinements may be made, but too much refinement is probably impractical.

It is convenient to make a list of all the causes of unaccounted-for gas and as the amount of unaccounted-for is estimated enter it opposite the proper classification.

By correcting for elevation or, more accurately, to actual barometric pressure, the errors due to the use of an arbitrary barometric-temperature correction are eliminated.

Unaccounted-for gas due to a *temporary rising of the delivery pressure* above the standard delivery pressure can be calculated from the quantity of gas delivered at the increased pressure.

Unaccounted-for gas due to *gas theft* is usually a small item and can be estimated quite readily.

Unaccounted-for gas due to *slow meters* can be estimated very closely by a study of the meter shop test records.

Unaccounted-for gas due to *D. R. Meters* is more difficult to estimate, particularly if the meter has been in service for any appreciable length of time before discovery.

Unaccounted-for gas due to *failure of meter to register pilot flow* in service. This loss is higher than is generally realized as many meters that are apparently registering this flow are actually measuring only a portion of it.

Unaccounted-for gas due to *main leakage* and to *service leakage* is virtually impossible to estimate by ordinary

means. It is best obtained by eliminating the estimated unaccounted-for due to all other causes and assume that the remainder is leakage. The portion of leakage ascribed to mains and the portion ascribed to services should be based upon judgment and should reflect the number and size of leaks repaired in mains as against the number and size of leaks repaired in services. Some operators require the estimated rate of leakage to be recorded upon the main or service repair order.

The factors affecting unaccounted-for gas just mentioned are the ones most commonly recognized. Generally speaking, the unaccounted-for gas due to any single one of the other contributing factors is relatively small; however, in the aggregate they may present a very sizeable figure.

Other Loss Causes

The losses due to other causes include:

Lost meters. Much ingenuity will be necessary to eliminate from the gas meters unaccounted-for, the condemned meters with lost or confusing records, meters destroyed by fire, those destroyed or lost during the demolition of a building and those carried along with the household goods when the tenants moved. The meters remaining may be considered lost until it can be determined what disposition was made of them. Too frequently some of these will be found set in some forgotten location without having been read in years.

Wrong index on meters. This error is not frequent but it does occur.

Service men increase delivery pressure at the customer's governor to give the customer adequate service. This is a very frequent occurrence and results in a substantial loss in meter registration.

Gas lost in purging mains and in making main connections and gas lost in purging services and in making service connections. The gas lost in these two activities may or may not be substantial but large or small they still contribute to the unaccounted-for gas.

Street lighting system losses remain with only a few companies so they are not a general problem.

Oil or water condensate in the distribution system. Such condensate results in unaccounted-for only if it has been metered while in the form of vapor.

Incorrect station meter or wrong correction factors used. The type, the design and the size of meter all have a bearing, as each meter has its own characteristics that must be recognized and taken into consideration.

Interconnections between systems. Such interconnections present many kinds of problems and consideration should be given to such conditions to determine if they are contributing to the unaccounted-for.

Unmetered company use. This is a very common condition and can result in a very substantial figure.

Too high pressures on the distribution system. This is a very common condition and is a substantial contributor to the unaccounted-for gas.

Leakage in customer's regulators. Such leaks are easy to repair but they are not easy to detect. Substantial leaks can develop in some regulator installations and can exist for a long time before being discovered.

The factors enumerated in this miscellaneous list are not present in all systems and some companies may have factors that have not been included.

Classification of Causes

While a detailed consideration of all factors contributing to unaccounted-for gas is necessary in order to identify and evaluate the causes, for ordinary consideration they may be placed in three general classifications: **Main Leakage, Service Leakage, and Causes Other Than Leakage.**

Some companies are fortunate enough to have constructed entirely new gas systems in towns or cities that did not have gas before. Such distribution systems are well built and have withstood severe pressure and leakage tests and are as nearly bottle tight as it is possible to make them. These companies have an excellent opportunity to check the amount of unaccounted-for gas due to causes other than leakage.

It is reasonably safe to assume that no material leakage will develop over the first several years. Any unaccounted-for gas that develops may be ascribed to causes other than main or service leakage. A correction should be applied to compensate for the meter reading lag where the load is changing rapidly. The longer the test period, the less influence the meter lag will have upon the test figures.

If enough of these tests and the surrounding conditions can be made available, the results will supply a firm basis for a more detailed study.

Acknowledgment

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FPC REPORT

MISSOURI NATURAL GAS COMPANY, Farmington, Missouri, and WESTERN KENTUCKY GAS COMPANY, Owensboro, Kentucky, have been exempted from regulation under the Natural Gas Act pursuant to the terms of the Hinshaw Amendment. This brings the total number of companies exempted to 88.

Hearings involving a $8,128,400 annual wholesale natural gas rate increase by NORTHERN NATURAL GAS COMPANY and two of its subsidiaries, NORTHERN NATURAL GAS PRODUCING COMPANY and PERMIAN BASIN PIPELINE COMPANY, all of Omaha, will be resumed June 15 in Washington, D. C. Hearings have been in recess since January 18.

Proposed wholesale natural gas rate increases totaling nearly $10 million annually have been filed by two interstate pipe line companies with the FPC. UNITED GAS PIPE LINE COMPANY, Shreveport, Louisiana, is seeking an increase of $5,856,000, approximately 7.1 per cent increase annually. MICHIGAN WISCONSIN PIPE LINE COMPANY, Detroit Michigan, has proposed an increase of $4,075,000 or approximately an 8.4 per cent increase per year. Both of the proposed filings would be in addition to increases that the firms are now collecting subject to refund. The higher rates are said necessary because of increased costs of rendering service, higher costs of purchased gas and the cost of additional facilities needed to purchase additional gas.

KANSAS-NEBRASKA NATURAL GAS COMPANY, Phillipsburg, Kansas, has applied to the FPC for permission to build 32.7 miles of line and increase compressor horsepower at five stations with a total of 2700 horsepower in the existing compressor stations.

IROQUOIS GAS CORPORATION, Buffalo, New York, has received FPC approval to develop a new underground storage area in New York state to be known as the "Nashville Storage Area" at an estimated cost of $2,877,200. The project would include 14 miles of delivery line, 22 miles of gathering and well lines, the drilling of 16 wells and reclaiming or re-conditioning of 64 existing wells. In addition a 900-hp compressor station will be built. The storage area would contain 8.5 billion cu ft and have a maximum daily output capacity of 80,000,000 cu ft.

Glossary of Gas Industry Terms—Bu to Dr

Butt-weld: A weld in which the two edges of metal do not over-lap but only meet and are then joined together by the weld metal.

By-pass: A piping arrangement with valve control, that carries gas, air or other fluid around, instead of through, an integral section of the complete piping system.

By-products: Materials obtained incidental to the production of the major product.

By-product Coke Oven Plant: A plant primarily for production of coke in which the gas produced is of secondary importance and hence a by-product.

By-products, Residual: Secondary products with commercial value obtained from processing of raw materials used in gas production. The by-products may result directly, or indirectly, as the result of further processing of residues.

C

Cable Tool: One of two principal methods of drilling for gas and oil; the other is rotary. Cable tool, the older method, consists of raising and dropping a heavy drill bit, suspended from the end of a crane, so that it punches and pulverizes its way through the subsurface structures. Water in the hole keeps the cuttings in suspension for removal at intervals by bailing.

Calorific Valves: Also called heat content, the amount of heat released by combustion expressed in calories or, usually, in Btu, for gas, per cubic feet.

Calorimeter: A laboratory instrument for determining the heating value of a fuel.

Cap: A cup-shaped fitting placed on the end of a pipe to seal the pipe, usually threaded on the inside and screwed over end of pipe. Also, the act of placing a cap on a pipe. Also, to close off a gas or oil well.

Capacity: The maximum load that a machine, apparatus, device, plant or system is capable of carrying under existing service conditions.

Caprock: The impervious geological structure that retains gas in a reservoir.

Carbon: An element, C, that has the widest use of all elements and enters into all organic material. It is infusible and is chemically inactive at lower temperatures; at higher temperatures, it burns and absorbs oxygen.

Carbon Black: Also called lamp black, a finely divided carbon produced by incomplete combustion of natural gas.

Carbon Deposition: The settling of carbon on such interior surfaces as in furnaces, coal gas equipment, coke ovens.

Carbon Steel: By common custom steel is considered to be carbon steel when no minimum content is specified or required for aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 per cent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60.

Carbon Dioxide: A gas CO_2 that indicates complete combustion of carbon; measured by analysis of flue gases.

Carbonization: Driving off volatile components of coal by the application of heat, leaving carbon behind.

Carbonizing Chamber: Interior of equipment used to carbonize coal, such as coke oven or coal gas retort.

Carbonizing Period: The time required to carbonize coal in a coke oven or coal gas retort.

Carbon Monoxide: A gas, CO, that indicates complete combustion of carbon, usually due to an insufficient supply of air; measured by analysis of flue gases.

Carborundum: Silicon carbide, a chemical compound of silica and carbon; hard, grey, crystalline materials used for abrasive equipment and in blocks to line combustion chambers.

Carburet: To charge a gas with carbon. To charge air with hydrocarbon vapor in such proportions that a combustible mixture is formed.

Carbureted Water Gas: Also called carbureted blue gas, it is the result of enrichment of water gas by adding oil gas, natural gas or similar hydrocarbon. Generally, carbureted water gas is made to have a heating value of 525 to 550 Btu per cubic foot.

Carbonizing: A heat-treating process in which carbon is introduced into a solid iron-base alloy by heating above the transformation temperature range while in contact with a carbonaceous material that may be a solid, liquid, or gas. Carburizing is frequently followed by quenching to produce a hardened case.

Casinghead Gas: Also called wet natural gas, it is unprocessed natural gas that is produced from strata that contain petroleum or condensate.

Casinghead Gasoline: The liquid hydrocarbon extracted from casinghead gas by one of the three methods. Compression, absorption or refrigeration.

Casehardening: A metal heat-treating process of surface hardening involving a change in the composition of the outer layer of an iron base alloy followed by appropriate thermal treatment.

Casing, Well: Steel pipe driven into gas or oil well, progressively as the well is drilled, to line the well as that is found necessary in the elimination of ground caving and of water infiltration. Casing is large enough to permit drilling tools to pass through.

Cast Iron Meter: Gas meter having case of cast iron as distinguished from a tin case meter in which case is of sheet metal. Also called iron case meter.

Catalytic Cracking: The decomposition or breaking down of oil or hydrocarbons through the action of a catalyzer.

Catalyzer: Also, catalyst, a material that brings about a chemical reaction without being permanently changed itself in the process.

Cathode: The negative pole in an electrolytic system, such as applied in cathodic protection; oxidation, or corrosion, does not occur at this electrode.

Cathodic Protection: A method of preventing the corrosion or deterioration of underground pipe and connected equipment, through the control of electrolysis. See: Anode and Cathode.

Caulk: To fill seams or joints with a packing material to seal them against leaks.

CC: Abbreviation for cubic centimeters.

Cement: An adhesive substance used for uniting particles or other materials to each other.

Centigrade: A temperature scale in which the freezing point of water is 0 deg and the boiling point of water at sea level atmosphere pressure is 100 deg.

Centimeter: A unit of length equivalent to one thousand-millionth part of the distance from the equator to a pole of the earth. It equals 0.393704 parts of an inch.

Centrifugal Compressor: A type of continuous-flow compressor that employs rotating, rather than reciprocating, elements.

Centrifugal Dryer: A mechanism for drying materials by spinning rapidly and throwing off water by centrifugal force.

Ceramic Radiants: Baked clay devices that become incandescent and radiate heat released to them by a gas flame.

Chain Tongs: A pipe-fitter's tool; a lever with a serrated end provided with a chain to embrace the pipe.

Channel: A hole or groove cut in a structure or material, longer than wide. Also, a hole through a fuel bed so that air by-passes combustion.

Charge: The quantity of material put into a batch process for each time of operation.

Charging Door: Also charging hole, the opening through which a charge is injected into equipment.

Charles' Law: The relation of temperature to pressure of a pure gas, according to this law, is that the volume under any condition of constant pressure is proportional to the absolute temperature.

Check Valve: A valve built to close automatically when flow in a pipe is reversed.

Checker Brick: Bricks stacked with large spaces between them for passage of gases so that heat can be absorbed from hot gases and then transferred to cooler gases, as in a carburetor or superheater in gas-making.

Chimney Effect: The suction of air through a fuel bed caused by the rising and expanding of hot combustion gases through a chimney.

Circulated Gas-Oil Ratio: The number of cubic feet of gas introduced into the well for gas-lift operations, per barrel of oil lifted.

City Gate: The point or measuring station at which a distributing gas utility receives gas from a natural gas pipe line company.

Class of Service: Types of service in gas utilization, usually divided into residential, commercial and industrial by the gas industry.

Clean-Out Door: Access opening through which clinkers, ash, and carbon deposits can be loosened and removed from a furnace or similar equipment.

Clinker: Fused lumps of ash.

Coal: A mineral that is solid and combustible, formed by partial decomposition of vegetable matter without access to air, it is composed of carbon, hydrogen, oxygen, nitrogen, sulfur, and miscellaneous constituents. The type of coal (peat, lignite, subbituminous, high-and-low-volatile bituminous, and anthracite) is determined by the relative content of carbon and volatile matter.

Coal Crusher or Pulverizer: Machinery for breaking coal down to desired size.

Coal Gas: Also called coke oven gas; it is manufactured by destructive distillation of bituminous coal in a gas retort or by-product coke oven.

Coal Gas Plant: A manufacturing plant in which coal gas is produced.

Coal Gas Retort: Equipment in which coal is carbonized and coal gas produced.

Coated Pipe: Pipe covered with a protective material to prevent corrosion.

Cock: A type of valve in which a tapered plug with a perpendicular hole through it is set into a tapered hole in the body of the valve. Holes are drilled through opposite sides of the body to line up with the hole in the plug.

Coke: The remaining hard porous substance left after coal gas has been removed from bituminous coal.

Coke End: The coke discharge end of a coal gas retort or coke oven.

Coke Oven: A high and narrow coal carbonizing oven.

Coke Oven Plant: Manufacturing plant using coke ovens instead of coal gas retorts to produce coal gas.

Coke Quenching Car: A rail car for transporting hot coke to the quenching tower where it is cooled by a water spray.

Coal Expanded Pipe: Seamless or welded pipe that is formed and then expanded in the pipe mill while cold so that the circumference is permanently increased by at least .50 per cent.

Cold Springing: Where used in the ASA code is the fabrication of piping to an actual length shorter than its nominal length; and forcing it into position, so that it is stressed in the erected condition; thus compensating partially for the effects produced by the expansion due to an increase in temperature. Cold spring factor is the ratio of the amount of cold spring provided, to the total computed temperature expansion.

Combination Gas: Natural gas rich in oil vapors. Wet gas. Also called casinghead gas.

Combination Utility: A utility that supplies gas and, generally, electricity to consumers.

Combustible Constituents: The components of gas that burn. In manufactured gas: illuminants, carbon monoxide, hydrogen, and methane. In natural gas: mostly methane with traces of ethane, propane and butane.

Combustible Gas Indicator: An instrument designed for the detection of the presence of combustible gases in an atmosphere.

Combustion Air: The air supplied to and through a burner, often mixed in the appropriate gas-air ratio, to get the desired combustion characteristics.

Combustion Chamber: The space in a furnace or fire box in which fuel is burned.

Combustion, Complete: The complete oxidation of a fuel regardless of whether or not this is accomplished with an excess amount of oxygen.

Combustion, Perfect: The complete oxidation of a fuel with exactly the theoretical amount of oxygen required.

Combustion Products: Also referred to as products of combustion, these are the unconsumed or remainder of a fuel after combustion; in gas combustion, generally, the combustion products are flue gases and water vapor.

Commercial Service: A class of gas service that applies to customers engaged in commercial or business activities that do not involve the direct

use of gas for the processing or manufacturing of products.

Compressibility Effect: In gas, the changes in density under changed conditions of compression.

Compression (Adiabatic). A method of compression in which heat is neither allowed to enter or leave the cylinder. The walls are considered as being perfectly insulated against loss of heat. Some exchange, however, always takes place in practice.

Compression Fitting: Mechanical joint for pipe in which the ends of the pipe are bolted together with a gasket pressed in the joint.

Compression (Isothermal): Compression in which the air or gas is kept at a constant temperature.

Compressor: A mechanical device for raising the pressure of a gas with a decrease in volume.

Concrete (Cement): An artificial stone made by mixing crushed stone, gravel, or slag with a mortar made up of sand and calcined cement such as Portland cement.

Condensable: A gas or vapor that can be converted to a liquid with application of available conditions of temperature and pressure.

Condensate, Condensation: Condensate is the liquid resulting when a vapor is converted by cooling or application of pressure. Condensation is the liquid accumulating on cold surfaces in contact with moist vapors.

Condensate, Natural Gas: The liquid that is produced in the retrograde condensation, by pressure reduction that may be accompanied by temperature reduction of high-pressure wet natural gas.

Condense: To convert from a gaseous form to a liquid. Also, to reduce the volume by removal of liquid or gas.

Condenser: A heat exchanger that removes heat from vapor causing it to condense into a liquid.

Conduction: The process of diffusion or flow of heat energy through a mass or body of matter by particle or molecular contact from the warmer to the colder parts.

Conductivity: The rate at which a material permits heat to pass through it, expressed in Btu per hour, per square foot of surface, per foot or inch of thickness, with a 1 F temperature difference across the thickness.

Connected Load: The total volume of of gas that can be utilized by all connected customers of a utility, expressed in cubic feet per unit of time.

Constant: An invariable number, or a number that denotes a fixed relation between two or more quantities.

Construction Type: A construction specification for pipe lines and mains that fixes the stress levels.

Continuous Furnace: An industrial furnace that heats or processes material as it moves continuously from loading, through the heating zone to unloading. For comparison, see: Batch Furnace.

Continuous Retort: A coal gas retort in which coal is constantly fed in and coke and coal gas constantly removed.

Controlled Atmosphere Furnace: A furnace or oven in which the chemical composition of the gases that are in contact with the material being heated, is maintained and controlled at a specified condition.

Control Piping: All piping, valves, and fittings used to interconnect air, gas, or hydraulically operated control apparatus or instrument transmitters and receivers.

Convection: The transfer of heat by moving masses of fluids. Usually, the motion or convection currents are created by density changes in the fluids at different temperatures.

Convector: Heating equipment that is designed so that its exposed surfaces will transfer heat to a passing fluid, such as air.

Conversion Factors: Constants or number required to change a set of dimensional units into terms of other dimensional units. British thermal units into horsepower, etc.

Conversion Burner, Conversion Unit: A burner, and its associated controls, using one fuel, that can be installed in place of a burner using another fuel. Usually, a gas burner in a furnace designed for coal or oil.

Conveyor: A mechanism for continuous movement of material from one location to another.

Cooling Coil: A coil of pipe used as a heat exchanger to cool material inside or outside the coil by means of colder material passing over or through the coil respectively.

Cooling Water: Water used to effect cooling in a cooling coil or other heat exchanger.

Corrosion: The process of wearing away, disintegrating, or destroying by the gradual separation of small parts of particles, especially by the action of chemical agents, as acids upon metals.

Coupling: A threaded sleeve used to connect two pipes.

Cracking: Processing that breaks down and rearranges the molecular structure of hydrocarbon chains. In thermal cracking, high temperature and high pressures are applied; in catalytic cracking, temperature and pressure are applied in the presence of a catalyst.

Cracking Temperature: The lowest temperature at which an oil will crack under specified pressure.

Critical Density: The density at the point where a physical change in a substance takes place. For example, that density at which crystallization begins.

Critical Pressure: The pressure that will just liquefy a gas at its critical temperature.

Cross: A pipe fitting with four branches arranged in pairs, each pair on one axis and the axes at right angles.

Cross-Connection: Applied to two or more pipes or piping systems in which fluid flow from one to another, for distribution or pressure purposes, is freely possible.

Cross Over: A small fitting like a double offset or the letter "U" with ends turned out. It is only made in small sizes and used to pass the flow of one pipe past another when the pipes are in the same plane.

Cross Over Tee: A fitting made along lines similar to the cross-over, but having at one end two openings in a tee head whose plane is at right angles to the plane of the cross-over bend.

Crown Support: Bracing framework that holds up the crown in large diameter tanks.

Crucible Furnace: A furnace in which the material being heated is contained in a temperature resistant pot or crucible.

Crude Oil: Liquid crude petroleum as produced from subsurface geological structures, before any processing or purification.

Cubic Foot, Standard: The volume of gas saturated with water vapor that at 60 F and a pressure of 30 inches of mercury ocupies one cubic foot. In the natural gas industry, generally, gas volumes are calculated on a dry basis at 60 F and a specified base pressure.

Curb Cock: A shut-off valve in a gas service line, usually between the curb and the consumer's property line.

Curb Line: Street or highway map line showing curb location.

Curb Shut-off: A buried valve or cock installed in a service pipe at or near the property line and accessible through a valve box and cover and operable by a removable key.

Customer: An individual, firm, or organization who purchases service at one location under one rate classification contract.

Customer Density: Number of customers in a given unit of area or on a given length of distribution line.

Customer's Meter: A meter that measures gas delivered to a customer for consumption on his premises.

Cut-off: Valve for shutting off flow of fluid in pipe.

Cycle: The related series of operations on a substance or work-piece required for completion of a processing or manufacturing step.

D

Daily Average Send-out: The total volume of gas delivered for a period of time divided by number of days in the period.

Daily Peak: The maximum volume of gas delivered in any one day.

Dalton's Law: Every portion of a mass of gas enclosed within a vessel contributes to the pressure against the sides of the vessel the same amount that it would have exerted by itself had no other gas been present. The pressure within a vessel is the sum of the partial pressures of each of the constituent gases.

Damping Valve: Used in vacuum gage tubes to eliminate, or dampen, the bouncing-action of gage needles.

Dead End: The closed end of a pipe or system of pipes.

Dead Line: A pipe line not in use.

Decline: The decrease in yield of an oil or gas well.

Degree: A division, space, or interval marked on a mathematical or other instrument as on a thermometer.

Degree Day: A term used to express the intensity of the heating season. It is the difference between 65 F and the daily mean temperature. The sum of these differences for every day of the heating season is the total degree days. Experience has shown that the gas heating season starts when the monthly mean temperature is 65 F, and that gas consumption for house heating is proportional to the drop in temperature below 65 F.

Degree F: Temperature as measured on the Fahrenheit temperature scale which sets the freezing point of water at 32 deg and the boiling point of water at 212 deg under sea level atmospheric pressure.

Dehumidification: The process of reducing the water vapor content of air or gas.

Dehydration: In general, the process of removing water, in all its forms, from solids or fluids.

Dehydrator: In the gas industry; equipment that removes water vapor from gas and air; frequently, the desiccant-charged adsorption-type.

Demand: The volume per unit of time at which a customer uses gas, averaged over a period of time.

Density: The mass of a substance per unit volume, usually expressed in terms of weight per cubic foot.

Derrick: An open-framework tapering tower, usually of steel construction, used as a support for raising and lowering well-drilling equipment. Cable tool derricks vary in height from 64 to 87 feet; rotary derricks, from 122 to 189 feet.

Desiccant: A sorbent material used for dehydration of fluids, usually in adsorption-type dehydrators.

Design Pressure: The maximum operating pressure permitted by the ASA code, as determined by the design procedures applicable to the materials and locations involved.

Designing Engineer or Designer: A technician who plans and installs equipment on a water flood project, pipe line, or refinery.

Destructive Distillation: Removal of volatile material from a solid, such as coal and wood, by application of heat.

Diaphragm: A flexible membrane separating two chambers.

Diaphragm Chamber: A hollow space in a device in which one side is a diaphragm.

Diaphragm Governor: A controlling device in which a diaphragm operates the mechanism.

Diaphragm Meter: A gas meter in which passage of gas through two or more chambers moves diaphragms that are geared to a volume-indicating dial.

Die: The name of a tool used for cutting threads, usually at one passage. The essential distinctive feature of a die is its multiple cutting edges, while a chasing or threading tool usually has one, or at most, only a few cutting edges.

Die Stocks: The holder and handles used to hold and operate hand dies for cutting threads on pipe or rods.

Diethyl: See: Butane.

Diethylene Glycol: A commonly-used desiccant for removing water chemically from gas.

Differential, Pressure: The pressure difference between two points in a system.

Diluent: A thinning substance added to a fluid.

Dilute: Mixing one substance with another so that the concentration of each in the mixture is reduced.

Dip Pipe: A pipe that conducts a gas below the level of a liquid and there discharges gas through the liquid.

Direct-Connected: Two machines or pieces of equipment connected to each other without any intervening gears or belts.

Discharge Coefficient: This is one of the factors used in calculating flow through an orifice and considers that a fluid stream, such as gas and air, contracts to a cross-section that is smaller than the cross-section of the orifice through which it passes and that there is an energy loss in turbulent flow.

Dissolved Natural Gas: Natural gas in solution with crude petroleum.

Distillation: A purification process in which vapors are boiled from a liquid by heat and the vapors condensed, with higher boiling materials remaining in the liquid and lower boiling ones concentrating in the vapor.

Distribution Company: A gas utility company that obtains its major gas operating revenue from retail gas sales to ultimate consumers.

Distribution Losses: The amount of gas lost through leakage or condensation in delivering gas to customers through pipe lines.

Distribution Main: Pipe carrying gas through service area and from which customer-connections are made.

Distribution System: The mains, service piping and equipment operated by a distribution company to deliver gas from local points of supply or manufacture to the customers' meters.

Diversity, also Diversity Factor: The time difference in use of gas by various classes of customers.

Dome: A geological structure that is favorable to the accumulation of gas and oil.

Down-draft Diverter: A device in a flue pipe to prevent down-drafts in the chimney or flue from reaching the combustion chamber.

Down-run: A time during the production period in the cyclic process of blue gas manufacture when steam is forced through the fuel bed from top to bottom.

Draft: The pressure difference that causes air or gas to flow into a heating chamber and through it into a stack. Draft can be natural or mechanically forced.

Draft Stack: Chimney or flue to discharge products of combustion to the atmosphere.

Drill Bit: The heavy cutting tool that is used in drilling oil and gas wells. The cable tool bit is solid and has a relatively blunt cutting edge that is applied in repeated chopping strokes. The rotary bit is generally like an auger and grinds through rock; mud of special character is forced through perforations in the bit to carry cuttings to the surface.

Part 3 of Gas Fundamentals will appear in the next issue.